UNITED STATES ARMY RESEARCH OFFICE

BROAD AGENCY ANNOUNCEMENT

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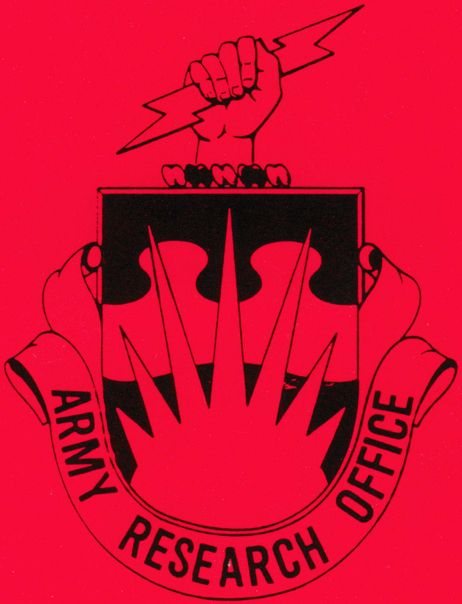

U.S. Army Research Office
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Research Triangle Park, NC 27709-2211

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Introduction

This Broad Agency Announcement (BAA) sets forth research programs of interest to the Army Research Office (ARO) and is issued under the provisions of paragraph 6.102(d)(2) of the Federal Acquisition Regulation (FAR) which provides for the competitive selection of basic research proposals. Proposals submitted in response to this BAA that are selected for award are considered to be the results of full and open competition and in full compliance with the provision of Public Law 98-369, "The Competition in Contracting Act of 1984."

Research proposals are sought from educational institutions, nonprofit organizations, and private industry for research in the biosciences, biological, chemical, electronic, engineering, environmental, materials, and mathematical sciences and physics. This BAA is intended to cover, in a general nature, all research areas of interest to ARO. Prospective offerors contemplating submission of a proposal are encouraged to contact the appropriate ARO scientist identified in Part I of this publication to ascertain the extent of interest in the specific research project.

Part II, Special Programs, discusses ARO's contribution to conferences and symposia, the Young Investigator Program (YIP), the Short Term Innovative Research (STIR) Program, the Research Instrumentation Program (RIP) and ARO's interest in Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs).

The ARO contributes support to a limited number of scientific conferences and symposia in special areas of science that bring experts together to discuss recent research or educational findings.

The YIP provides research opportunities for outstanding young university faculty members and enhances their research interests and capabilities.

The STIR is a mechanism for private industry, institutions of higher education and nonprofit organizations to advance a scientific or technical research idea or to continue as an outgrowth previous experimental or theoretical exploration on a short term basis.

The RIP allows U.S. universities to improve their capabilities of conducting research and educating scientists and engineers in areas of importance to the national defense.

ARO has a long history of supporting research at historically black colleges and universities and minority institutions. We actively seek quality research proposals from HBCUs and MIs in full competition with all offerors who may submit proposals under this BAA. Such proposals may be submitted at any time. We also encourage the inclusion of HBCUs and/or MIs as part of a consortium proposal or as subcontractors/subgrantees to prime recipients.

Under the programs covered by this BAA, the ARO receives approximately 700 proposals each year and historically funds approximately 200 new awards each year.

In accordance with federal statutes, regulations and Departments of Defense and Army policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving financial assistance from ARO.

This BAA consists of five parts as follows:

Part I - ARO Research Interests
Part II - Special Programs
Part III - Proposal Evaluation
Part IV - Proposal Preparation
Part V - Proposal Forms

Offerors submitting proposals are cautioned that only a Contracting or Grants Officer may obligate the Government to any agreement involving expenditure of Government funds.

This BAA also applies to research proposals submitted from Europe, Africa, Middle-East, and Southwest Asia to the US Army's European Research Office, USARDSG-UK (ERO).

Please note that ARO prefers that proposals submitted in response to this BAA cover a 3-year period and include a brief summary of work contemplated for each 12-month period so that awards may be negotiated for an entire 3-year program or for individual 1-year increments of the total program.

All administrative inquiries regarding this BAA shall be addressed to voice mailbox number 919-549-4375.

This BAA is a continuously open announcement valid throughout the period 1 October 1995 through 30 September 1997 (Fiscal Years 96 and 97) and supersedes the ARO BAA dated October 1993.

Gerald J Iafrate

GERALD J. IAFRATE
Director

PART I

ARO

RESEARCH

INTERESTS

ARO RESEARCH INTERESTS

The ARO program is organized by scientific discipline, and the reader will note some overlap among sections.

The research areas described may have short or long range impact on Army capabilities. If progress in certain areas requires the interaction of several investigators, and especially if an interdisciplinary approach is necessary, the Army Research Office will consider proposals for comprehensive research programs. Only a small number of such large programs can be initiated in a single fiscal year. Inquiries related to comprehensive and interdisciplinary programs should be sent to the Director, ARO.

Proposals may be submitted at any time. We strongly encourage informal discussion and submission of a brief summary of the proposed research prior to the submission of a formal proposal. Key ARO staff members with telephone numbers for each area of interest are identified as part of the description of that area.

Twenty copies of the proposal are required. Offerors should complete ARO Form 51 and ARO Form 52 or 52A as part of the proposal submission. These forms are included in Part V of this BAA. Proposals should be sent to the following address:

U.S. Army Research Office
ATTN: AMXRO-ICA
4300 South Miami Boulevard
P. O. Box 12211
Research Triangle Park, NC 27709-2211

In the European hemisphere:

U.S. Army European Research Office
USARDSG-UK
P. O. Box 2190
London, NW1 5TW

BIOSCIENCES

Physiology and Performance

Biodegradation

Basic Research In Biotechnology

Defense Against Chemical and Biological Agents

Optimization of Physical Principles in Biological Systems

BIOSCIENCES

I. INTRODUCTION

Extramural research in the biosciences is supported by the U.S. Army Research Office. For those proposals related to purely medical topics, the investigator is invited to contact the U.S. Army Medical Research and Materiel Command. For research in the behavioral and social sciences or in training techniques, contact the Army Research Institute for Behavioral and Social Sciences.

The ARO Biosciences research program is currently focused on the areas described below. If you desire further information, or if you have research ideas that you wish to bring to our attention, please contact Dr. Shirley R. Tove, (919) 549-4344, (e-mail: Tove@aro-emh1.army.mil), Dr. Robert J. Campbell, (919) 549-4230, (e-mail: Campbell@aro-emh1.army.mil), or Dr. Donna M. Cookmeyer, (919) 549-4343, (e-mail: Cookmeyer@aro-emh1.army.mil). We prefer that you submit a short, informal pre-proposal of your ideas (1-2 pages). This will be evaluated in terms of Army interest and suitability for submission as a full proposal. This informal "white paper" should include research objectives and an experimental plan or method of approach. A small number of symposia, conferences and workshops are also supported in part or in whole to provide an exchange of ideas related to ongoing programs in Army laboratories.

II. RESEARCH AREAS

Please direct proposals to the attention of the scientist(s) listed beside the appropriate research area. If unsure, any of the three scientists listed above may be contacted.

A. Physiology and Performance (Dr. Donna M. Cookmeyer)

Basic research on response and adaptation to environmental signals, and strategies that organisms employ to survive adverse environmental conditions. Information on sensory and motor capabilities/limitations as related to peak soldier-machine system performance. Clarification of the functional physiology underlying the observation and interpretation of input cues by sensory systems. Studies on the impact of visual, auditory, and multiple source processing, especially as impacted by stresses of various kinds; strategies for limiting performance degradation during extended operations. Research on improving soldier sustainment, especially new preservation/stabilization technology for rations.

B. Biodegradation (Dr. Shirley R. Tove)

Research on: biochemical and physiological mechanisms underlying biodegradative processes in normal, extreme, and engineered environments; properties of materials that make them susceptible or resistant to biological attack.

C. Basic Research in Biotechnology

Microbiology and Biochemistry, Dr. Shirley R. Tove
Biochemistry, Biophysics, and Cell Biology, Dr. Robert J. Campbell
Molecular Biology and Genetics, Dr. Donna M. Cookmeyer

Research on: structure/function of macromolecules; gene expression and regulation; macromolecular interactions; characterization of enzymes and receptors; mimicking or improving existing protein functions; subcellular compartmentalization or targeting, membrane biochemistry, and signal transduction.

D. Defense Against Chemical and Biological Agents (Dr. Shirley R. Tove, Dr. Robert J. Campbell)

Basic research on: the modes of action of potential agents on physiological targets including neurotransmitter interaction; mechanisms of enzymatic or enzyme-mimetic catalysis; biologically based concepts for detection; rapid identification of biologicals.

E. Optimization of Physical Principles in Biological Systems (Dr. Robert J. Campbell)

Research to understand what nature has to offer in the way of biological materials, processes, and structures that might be used directly in, or provide insight and conceptual models for, systems with potential for materiel application. Includes novel theoretical principles and mechanisms ("lessons from nature"), as well as materials with extraordinary properties, from biological sources. Studies designed to describe biologically derived architectures with regard to both process and product.

CHEMISTRY

Analytical Chemistry

Chemical Kinetics

Electrochemistry

Inorganic Chemistry

Organic Chemistry

Polymer Chemistry

Surface and Interfacial Chemistry

Theoretical Chemistry

CHEMISTRY

I. INTRODUCTION

Chemistry is central to the operation of the Army. Explosives, propellants, fuel cells and batteries function by converting chemical energy into mechanical and electrical energy. Macromolecules, especially elastomeric ones, provide materials for equipment. Protection of the soldier against chemical agents requires the detection, identification, and destruction of such chemicals, and the design and construction of barriers to their passage. The destruction of toxic wastes represents another chemical problem faced in the restoration of military real estate and the safe demilitarization of surplus munitions.

We invite proposals for research to advance our understanding of chemical phenomena with a strong prospect for use in future Army technology. We prefer that interested applicants first send us a short (1-2 page), informal description of their ideas so that we can determine whether submission of a formal proposal would be appropriate. The following descriptions of topical areas are representative of our interests, but are not exhaustive.

II. RESEARCH AREAS

A. Analytical Chemistry

This is a highly focused program geared toward addressing specific Army needs for both battlefield and environmental applications. Research areas may include the development of novel detection and identification schemes, small light-weight sensors, methods for enhancing sensitivity and accuracy, development of multidimensional analytical techniques, real time analysis, and development of predictive and interpretive models. Proposals in this area will only be considered for studies that directly impact ongoing Army research. (Contact: Dr. Douglas J. Kiserow, (919) 549-4213)(e-mail: Kiserow@aro-emh1.army.mil)

B. Chemical Kinetics

The Army's program in ignition and combustion processes associated with energetic materials, explosives, detonation phenomena, the control of energy release and energy transfer processes will benefit from increased understanding of fast reactions of energetic species. We are especially interested in the investigation of chemical reactions using time resolved techniques to observe transient species and infer reaction pathways. Research on transformation of toxic materials in chemical reactors, especially those using supercritical water, are also of interest. (Contact: Dr. Robert W. Shaw, (919) 549-4293)(e-mail: Shaw@aro-emh1.army.mil)

C. Electrochemistry

Electrochemical phenomena provide the Army with power (fuel cells, batteries) and a wide range of materials and devices (coatings and films, microelectronics, chemical sensors). We support research leading to quantitatively reliable models of electrochemical systems including studies of charge transfer and adsorption phenomena at electrified interfaces; transport through coatings, surface films and polymer electrolytes; extended structure of interfacial regions and electrodeposition mechanisms and morphology studies; electrocatalysis; and electrosynthesis. (Contact: Dr. Richard J. Paur, (919) 549-4208)(e-mail: Paur@aro-emh1.army.mil)

D. Inorganic Chemistry

Many important advances in inorganic chemistry are now taking place in boundary or interdisciplinary areas such as solid state chemistry, organometallic chemistry, and bioinorganic chemistry. Modern inorganic chemistry is making significant contributions to the understanding of the reaction chemistry of inorganic surfaces of value to the Army in catalyst design and ultrahard coatings. Metal ions can form the basis for designed catalysts to activate molecular oxygen to produce useful oxidation systems, as well as to promote the four-electron reduction of molecular oxygen to water for an efficient fuel cell. Syntheses combining main group species with transition metals can lead to novel molecular materials. (Contact: Dr. Reginald P. Seiders, (919) 549-4365)(e-mail: Seiders@aro-emh1.army.mil)

E. Organic Chemistry

Molecules targeted for special attention include pigments and dyes with emission and reflectance characteristics useful for camouflage and controlled signature applications, potentially important monomers, especially for elastomer preparation; organosilicon compounds with interesting material properties; or molecules with potential use as powerful reagents. New, more efficient, and environmentally benign organic reactions, both stoichiometric and catalytic, are of interest, especially nitration, oxidative and nucleophilic displacements at phosphorus and sulfur, and polymer-bound reagents. Selected mechanistic studies which promise new insights to the pathways of the above reactions are encouraged. (Contact: Dr. Reginald P. Seiders, (919) 549-4365)

F. Polymer Chemistry

The focus of this program is molecular level polymer research leading to new materials, blends, or modifications of existing materials with tailored properties including improved chemical resistance, selective permeability, resistance to environmental changes, reduced weight with increased strength, and novel electronic and optical properties. The emphasis is on elastomer research; however, studies of other novel macromolecules will be considered. Research areas of current interest include synthesis of new molecules, self assembly, molecular architecture, and dendritic macromolecules. (Contact: Dr. Douglas J. Kiserow, (919) 549-4213).

G. Surface and Interfacial Chemistry

This program is highly relevant to the Army's Chemical Defense program. It primarily supports research on the decomposition of hazardous molecules on well characterized surfaces, and in organized media (e.g. micelles, microemulsions, vesicles, and monolayer films) at liquid-liquid and liquid-solid interfaces. The development of new experimental probes of these reactions is also of interest. The most important species are organo-phosphorus, -sulfur, and -nitrogen molecules, and reactions of organic functional groups on surfaces and in these organized media. The principle reactions of interest are hydrolysis and oxidation, and catalysis is a strongly desired goal of these studies; however, new concepts are encouraged. Photo-oxidation and electron transfer reactions are also of interest, and we encourage investigations into the effect of microenvironment on chemical reactivity. (Contact: Dr. Reginald P. Seiders, (919) 549-4365)

H. Theoretical Chemistry

Army requirements for insensitive munitions, for propellants and explosives with greater energy density, for the control of propellant burning rates and controlled energy release from explosives provide a continuing interest in a variety of theoretical explorations. Theoretical investigations may provide predictive capabilities relevant to the properties and behavior of a wide spectrum of energetic materials and their prototypes. More specifically: studies of energy transfer mechanisms in condensed phases, the prediction of molecular reactivities, the investigation of heterogeneous reactions and the prediction of reaction pathways. (Contact: Dr. Robert W. Shaw, (919) 549-4293)

ELECTRONICS

Solid State Devices

Opto-electronic Devices

Wireless, Tactical Communications Networks

Image Analysis and Information Fusion

Minimum Energy/Low Power Electronics

Electromagnetics and Millimeter Wave/Microwave Circuit Integration

Joint Services Electronics Program (JSEP)

ELECTRONICS

I. INTRODUCTION

Research in electronics is performed in the areas of *Solid State Devices* including semiconductors, magnetics, dielectrics, and circuit designs; *Optoelectronic Devices* including electro-optical devices and materials, optoelectronic components, optical communications, and optical signal processing; *Wireless, Tactical Communications Networks,* including networking, adaptive protocols, signal processing, modulation, coding, and circuits; *Image Analysis and Information Fusion,* including image, target, and clutter modeling, fusing information from multiple sources, and high performance architectures; *Minimum Energy/Low Power Electronics*, including minimum energy processing, circuit and systems design for high efficiency/low voltage, mobile systems and networks, adaptive power management, and component technologies; *Electromagnetics and Millimeter Wave/Microwave Circuit Integration*, including integration technologies, optically controlled mm-waves/microwaves, antennas, EM simulation, and propagation and scattering effects. The objective is to identify and solve critical Army research problems where progress has been inhibited by a lack of novel concepts or fundamental knowledge. Work under this task has application to a wide variety of development efforts and contributes to the solution of technology-related problems in communications, command and control, surveillance, target acquisition and night observation, intelligence, and electronic warfare. The following sections contain information on these research areas and specific research thrusts. (Contract: Dr. Charles H. Church, (919) 549-4240) (e-mail: Church@aro-emh1.army.mil))

II. RESEARCH AREAS

A. Solid State Devices

This research area includes the acquisition of basic knowledge on electronic, magnetic, and optical materials and structures for microelectronics. The Army seeks to understand those parameters of electronic materials which potentially affect or determine characteristics of future high-performance devices. To establish the science base for future Army battlefield capabilities, innovative research is sought in the general areas of advanced electronic materials, processing and fabrication science, advanced device concepts, and electronics-based microdevices. Areas such as generation, transport and control of charge carriers in semiconductors, and electronics contributing to novel optical, electro-optical and optoelectronic systems are of interest. Specific research fields of current interest are electronic and structural properties of elemental, binary, ternary and quaternary semiconductors; semiconductor surface and interface studies; active quasi-optical device effects at millimeter wave frequencies; as well as novel electro-optical and optoelectronic devices and interconnects. (Contact: Drs. Michael Stroscio, (919) 549-4242 (e-mail: Stroscio@aro-emh1.army.mil) and John Zavada, (919) 549-4297 (e-mail: Zavada@aro-emh1.army.mil))

Studies of the new or improved operating principles for semiconductor devices as well as investigations concerning the fundamental limitations of the operating range of devices will provide directions for potential improvements. Included in this research effort is the evaluation of existing device barrier problems in the fields of generation, detection and processing of electronic signals. Research in semiconductor devices is emphasized to increase the power-frequency product or the bandwidth of new classes of electronic devices and to study transit time effects on semiconductor devices. (Contact: Dr. Michael Stroscio, (919) 549-4242)

Army electronics systems for the twenty-first century will require a four-order-of-magnitude increase in real-time signal processing capability. Requisite device speed and densities demand that the initial feature size be lowered from the current few-micron (micrometer) level, through the VHSIC domain (1.5-0.5 micron), to the ultra-submicron region (0.1 micron and below). Planned systematic technological realization of submicron and ultrasmall devices cannot be achieved without research to understand the physical laws describing bandstructure, charge transport, interaction effects, etc., in the submicron realm. Research needs at this stage may be grouped in five major problem areas; (1) carrier transport properties, non-equilibrium phenomena, and dissipative interactions; (2) electrical characterization (including picosecond characterization) of ultrasmall electronic structures; (3) electronic properties of subdimensional structures and heterojunctions; (4) novel device structures, with emphasis on nanoscale and mesoscopic devices; and (5) the coupling of ultraviolet, visible and infrared radiation to novel direct bandgap semiconductor structures. Novel devices based on mixed-mode principles portend numerous multifunctional information handling applications. Whereas many current devices depend primarily upon a single phenomenon for their operation, these new devices exploit a complexity of interactions between a variety of fields, including quasi-static electric and magnetic, electromagnetic, optical and quasi-optical, thermal, and elastic. Advanced device concepts for use on the Digital Battlefield are needed, including: efficient, low power components; sensing of ultraviolet, visible, and infrared radiation by semiconductor structures; silicon-based heterojunction devices (e.g. mixed material devices such as SiGe and III-V compounds on Si); terahertz device technology in the 100-1000 GHz region; optoelectronic devices for optical interconnects; micromechanical and microphotonic integrated sensors; vacuum microelectronic device structures; devices based on high temperature superconducting materials; and molecular electronics. To ensure the timely insertion of ultrasmall electronics technology, program thrusts will include research on input-output coupling of nanoscale devices. Semiconductor device research will be conducted with the aim toward ultra high-speed and low-power integrated circuits. (Contact: Dr. Michael Stroscio, (919) 549-4242)

The Army is interested in the following electronic component areas; (1) ultrafast switching transistors and optoelectronic devices for high processing bandwidths in signal and data processing, (2) monolithic ultrasubmicron device components and networks capable of application-specific signal processing, and (3) high frequency microwave/millimeter-wave transistors for communications (both discrete devices and monolithic integration). State-of-the-art techniques for fabricating quantum-scale structures are emphasized. Research in support of these objectives includes submicron device modelling and scaling novel device structure concepts (e.g. vertical integration ballistic devices and quantum-well concepts), submicron device fabrication for enhanced functional throughput rates as well as small power-delay products and diagnostic IC fabrication. Processing that complements these device studies is also of interest, in particular: ultrasmall-linewidth etching, lithography, metallizations and electronic materials deposition. (Contact: Dr. Michael Stroscio, (919) 549-4242)

B. Opto-electronic Devices

Research on the generation, guidance and control of optical signals in both semiconductor and dielectric materials is of interest. In particular, novel electro-optical processes leading to greater manipulation and increased data handling capabilities are to be considered. To establish the science base for future Army battlefield capabilities, innovative research is sought in the general areas of advanced optical materials, optical and infrared sensors, solid state and semiconductor lasers, as well as optoelectronic devices and circuits. Representative areas of investigation include: Photonics in III-V and II-VI compound semiconductors; methods for altering optical and electronic properties of materials; investigations of semiconductor interfaces; light emission in Si nanoparticles; blue/green lasers and LED's; and rare-earth doping of semiconductors and dielectrics. (Contact: Dr. John Zavada, (919) 549-4297)

The Army requires high resolution, high sensitivity, "multicolor" infrared imaging arrays for target acquisition, recognition, and identification. Future systems need to be developed for the fusion of data from infrared sensor suites involving several wavelengths. Research opportunities include components based on II-VI, III-V quantum well, and group IV semiconductor materials operating in the 3-5 and 8-12 microns regions as well as the necessary manufacturing tools for large area, affordable arrays. Army image processing requirements necessitate operations on a million pixels at rates up to a thousand frames/second at resolutions above twelve bits. Development of the necessary architectures and the optical processing components provide research challenges. "Smart" sensors that combine detection with optical processing as well as diffractive optical components that couple light between smart pixel arrays are of interest. (Contact: Dr. John Zavada, (919) 549-4297)

High speed signal processing and computing, as well as data storage, will require advanced laser diodes. Blue-green lasers are needed for photorefractive-based optical processing components and data storage on optical disks. Research is necessary in II-VI semiconductor materials growth and device processing to improve the efficiency and reliability of the output of the devices at these wavelengths. Research is also required in the optical properties of III-V nitride semiconductor materials for laser applications. For optical processing of images, research leading to 2-D arrays of surface-emitting lasers is necessary. (Contact: Dr. John Zavada, (919) 549-4297)

As the needs for information processing become more complex, the advantages of optical interconnection techniques become very clear. Optical interconnect components are needed in guided-wave data links for computer interconnection and in free-space links for optical switching and processing. In either case, research addressing efficient, reliable optical components is needed. (Contact: Dr. John Zavada, (919) 549-4297)

Major advances in low power requirements and very-high speed operation of electronic/optoelectronic circuits will require breakthroughs in the control and precision of device geometries at the atomic level. Precise control in both vertical and lateral dimensions is needed for selective etching, material deposition, and doping techniques. Research in the following areas is needed: low-resistivity, very shallow ohmic contacts; high-selectivity etching techniques with minimum damage effects; in-situ monitoring techniques for precise control of material deposition and etching; and automatic control of lithography at the nanoscale. (Contact: Dr. John Zavada, (919) 549-4297)

C. Wireless, Tactical Communications Networks

The communications research program is concerned primarily with establishing the fundamental understanding necessary to support the Army's future tactical communications needs. The Army is interested in communication systems operating in frequency bands traditionally occupied by narrowband radios as well as systems operating in frequencies extending into the millimeter wave region. These systems must support broad-based and highly mobile communications "on-the-move" and must perform in environments of impressive diversity, from dense foliage to dense urban obstructions and jamming. Research is required to support the modeling of wideband channels, the understanding of data transmission characteristics at MMW, channel parameter estimation, signal design, and coding for multiple access channels with interference. Research in data compression and error control will also contribute. There is an interest in basic research to develop theory to support the design of advanced highly mobile, multi-band multi-mode communication receiver and transmitter architectures employing techniques to minimize power dissipation for near optimal performance over a wide range of channels. (Contact: Dr. William Sander, (919) 549-4241)(e-mail: Sander@aro-emh1.army.mil)

Future Army tactical communication systems for the digital battlefield will consist of many different types of networks and must be capable of communications on the move. These systems will be highly mobile creating highly dynamic inter-networks using HF, VHF, UHF, microwave, and millimeter wave frequencies. The system is likely to be spread spectrum packet radio. Network control must be distributed to avoid single points of failure. If trunks or master stations are used they must be mobile. The system should be self-organizing with peer to peer capabilities. Adaptivity should be considered in all aspects to optimize performance. Interoperation and gateways for real-time internetwork routing are important. Formal methods for protocol and network modelling, intelligent protocols, formal models of protocol performance and conformance, protocol conversion for tactical gateways, and adaptive protocols are some network protocol topics needing research. Research on many aspects of these systems is desired, for example, survivability in an electronic warfare environment is a requirement. Research is sought which supports spread spectrum, multiple access, anti-jam and low probability of intercept capabilities, and adaptive antenna array processing. Many signals in military communication systems have unknown or time-varying characteristics, motivating the need for research in both the theory and modeling of stochastic signals in noise and interference. Research which applies innovative new technologies such as neural networks and stochastic and nonlinear dynamical system theory to the advancement of communications is also sought. (Contact: Dr. William Sander, (919) 549-4241)

Another thrust is optical communications in which the goal is to utilize optical techniques within distributed, multichannel, wide-bandwidth communications, command, and control systems. Included within this effort are techniques which lead to high-speed optical signal processing and information transmission in the optical domain. (Contact: Dr. John Zavada, (919) 549-4297)

D. Image Analysis and Information Fusion

Numerical methods to recognize objects in a scene have found application in such areas as industrial inspection and robotics, and are reasonably successful when the environment is constrained. However, possibly the most difficult of the application areas of Image Analysis is that of Automatic Target Recognition (ATR), in which the background of the scene is cluttered, the objects are far away, and the view may be obscured or blurred. The focus of Image Analysis research is the pursuit of theories and algorithms which will result in robust automatic systems, as well as the development of methods to validate the performance of such systems. Although ATR is certainly not the only application area of interest to the Army, it is the area of highest priority. The interaction of targets and background clutter is of paramount importance in the separation of target and background. The theory of this interaction is a major research goal and has relevance to several areas of ATR research including an objective measure of clutter that may be used in comparing models, scenes, and results. Research is needed which addresses defining clutter metrics, the manner in which clutter degrades the discrimination processes, and its interaction with the target. (Contact: Dr. William Sander, (919) 549-4241)

The detection, recognition, and identification of a three-dimensional object from its two-dimensional image, especially where the object is obscured, concealed, or partially occluded in an image of a scene cluttered with other target-like objects is a difficult and challenging task requiring continued algorithm development. Such algorithms may be helped by the knowledge of the context, the nature of the ambient conditions, and other relevant parameters such as motion. Research is needed which investigates the acquisition, representation, and use of a-priori knowledge in applications in which the information in the signal, by itself, is fundamentally inadequate for the recognition task. Such knowledge may take the form of statistical or chaotic representations of the target and the clutter as well as other forms. Research is needed which addresses (i) the object recognition issues in general, (ii) how the use of known parameters and conditions may alleviate the difficulty of the recognition problem, and (iii) how the performance of the resulting algorithm/system may be evaluated. Projects which incorporate all these components are particularly attractive. All proposals submitted in response to this initiative must include consideration of methods for determination of the conditions under which the technique succeeds or fails. (Contact: Dr. William Sander, (919) 549-4241)

There is a need for development of fast ways to perform Image Analysis computations, especially for applications which demand closed loop execution, such as missile guidance. If fast implementation of such algorithms requires special purpose computing architecture, then such architecture may be considered a component of the research; however, it should be emphasized that this is not a thrust area in architectures per se, but rather in methods for fast implementation of algorithms which have specific application to ATR. (Contact: Dr. William Sander, (919) 549-4241)

There is a need for research directed toward determining information-theoretic bounds on the performance of any algorithm, given parameters of the sensor and the scene. Such parameters include SNR, target resolution and contrast, etc. Such a performance bound would provide a uniform standard against which the performance of proposed Image Analysis algorithms could be judged. (Contact: Dr. William Sander, (919) 549-4241)

Current research in neuroscience and the biological sciences is shedding increasing light on the neural and cognitive mechanisms and systems used by humans and other biological forms in performing tasks in vision, perception, detection, recognition and discrimination. The purpose of this thrust is to promote the adaptation, transfer, and application of knowledge of neural and cognitive mechanisms and architectures of biological systems to develop the science and technology for Image Analysis in general and ATR in particular. The proposed research should demonstrate understanding of computer-based object recognition issues and must address how the biological models address significant related problems. (Contact: Dr. William Sander, (919) 549-4241)

Processes such as target detection, target recognition and classification, and tracking often require fusion of information from potentially diverse sources. The increasing volume and variety of battlefield data makes the "higher" levels of information fusion--situation and threat assessment, mission management-- increasingly crucial. Decision-making at these higher fusion levels often involves forms of ambiguity more extreme than those addressed by conventional statistical analysis: imprecision, vagueness, indiscernability, etc. Therefore, it is essential that information from sources such as images, signals, voice messages, geographical information, natural language text, and prior knowledge/rule bases be presented in a unified framework. Mathematical methods for measuring and representing information content in diverse and ambiguous data are fundamental. Recent approaches (Dempster-Shafer, fuzzy logic, rule-based, rough sets, statistical capacities, etc.) offer a way of dealing with highly ambiguous information. A systematic, tractable framework is needed that will allow diverse input data streams to be transformed into a unified information fusion space. Such measures should enable prediction of the level of system performance achievable based upon the information content of sources available, knowledge gained from previous experience, tasks to be performed, and constraints in the context of the task to be performed. (Contact: Dr. William Sander, (919) 549-4241)

In higher levels of information fusion such as situation and threat assessment and mission management, the primary objective is to simulate a human expert (e.g. rule-based system, adaptive system, neural networks, etc.). Issues which require further research include: more systematic approaches to situation assessment which permit effective performance analysis, prediction, and evaluation; and assessment of measures of stability and performance. A common methodology should be developed that would support the optimal, adaptive management of information collection resources. (Contact: Dr. William Sander, (919) 549-4241)

E. Minimum Energy/Low Power Electronics

The future Army communications, information processing, imaging, and other systems must be portable, functional, versatile, and highly reliable. In addition, the systems will require ultra-high speed capability for handling complex voice, data, and video multimedia signal formats. Many of the new systems will find application in wireless communications, infrared imaging, and portable diagnostic and computational equipment. As these systems become more sophisticated, the necessary electronic circuitry becomes more complex, with increased prime power requirements. Currently, and in the near future, prime power for mobile and light weight system utilization is limited. It is necessary, therefore, to develop a new generation of electronic and other systems that can operate under minimum energy constraints with very low dc power dissipation. The Army has interest in understanding the fundamental principles associated with minimum energy operation. Systems of interest include weapons and logistics systems, communications, telemetry, tracking, surveillance, diagnostic, intrusion alarms, etc. Light weight and low power consumption visual displays will be required. There is interest in novel research on the device, component, and system level. An area of particular interest is research that will result in reduced power dissipation in RF transmitters and receivers. (Contact: Dr. James Harvey, (919) 549-4244 (e-mail: Harvey@aro-emh1.army.mil), Dr. John Zavada, (919) 549-4297 and/or Dr. Charles H. Church (919) 549-4240)

Fundamental research directed towards developing an understanding of the minimum energy required to provide functions such as communications will provide a basis for advanced system development. This involves determining the minimum energy that can be detected and the corresponding minimum energy required to be generated. Such analyses should include background noise, transmission losses, multipath, atmospheric attenuation, etc. Both theoretical and experimental projects are of interest. The systems will include both low dc power consumption digital and RF circuits. The digital portion of the unit would operate at low bias voltage to significantly reduce power dissipation. The RF transmit/receive portion of the communications system dissipates a significant fraction of the total dc power. Due to limitations imposed by the transmission requirements a finite level of RF energy must be transmitted. Therefore, it will be necessary to develop a new generation of high-efficiency, low loss systems that can operate under minimum energy limitations. (Contact: Dr. James Harvey, (919) 549-4244)

Research on advanced modulation and coding techniques and associated circuit architectures that result in high integrity signals under reduced energy consumption conditions will provide the Army with the concepts necessary to realize next generation systems. Analyses that examine the tradeoffs between time domain and frequency domain techniques are of interest. Novel modulation techniques that will permit oscillators and power amplifiers to be operated under maximized high power-added efficiency conditions while maintaining linear performance need to be developed. It is anticipated that digital techniques will be widely utilized to make more effective use of available bandwidth, while maintaining high performance operation. (Contact: Dr. James Harvey, (919) 549-4244)

Novel semiconductor devices that can operate with high performance at low power dissipation will provide the building blocks to realize the new systems. Both digital and RF devices will be required. However, the Army has particular interest in RF devices for transmitters and receivers. System operation will extend from the low microwave bands to the millimeter wave region, depending upon the particular system application. Mixed mode circuits that utilize both digital and RF devices in novel architectures that permit functions to be implemented with minimized device counts and reduced energy consumption are attractive. Simple voltage scaling, while appropriate for CMOS devices, may not be optimum for low power RF devices. Research that clarifies this issue is of interest. (Contact: Dr. James Harvey, (919) 549-4244)

Passive components such as filters, antennas, mixers, couplers, etc. are necessary building blocks for an electronic system. Research directed towards implementing these circuit functions in novel formats that are suitable for use in advanced integrated circuits will permit maximized integration to be achieved. Directed beam, phased array, and adaptive antennas are of particular interest since they permit high gain to be obtained. Advanced filters with narrow bandwidth and high off-band rejection and that can be implemented in small size suitable for use in integrated circuits are desirable. (Contact: Dr. James Harvey, (919) 549-4244)

Advanced models and simulation tools that can accurately predict device, circuit, and system performance need to be developed. The Army has interest in physically based models that allow dc and RF performance to be determined as a function of material, device design, bias, RF circuit, and operating parameters. It will be necessary to include large-signal, thermal, and breakdown effects. Simulators that include statistical design capability and yield determination will find use in reducing manufacturing costs. Advanced models for directed beam antennas, filters, mixers, etc. are also of interest. (Contact: Dr. James Harvey, (919) 549-4244)

F. Electromagnetics and Millimeter Wave/Microwave Circuit Integration

Three drivers of Army interest in the fields of EM and millimeter wave/microwave circuit integration are the unique capabilities available for Army electronic systems operating at mm-wave frequencies and higher on the digitized battlefield of the 21st century, the need for innovative component and circuit advances for personal and mobile communications systems, and the need for exceptional capabilities for tactical antennas at lower RF frequencies. Novel systems capabilities can result from the unique propagation characteristics of the mm-wave frequencies, their imaging resolution, the potential system size reduction, and their large bandwidth. At lower frequencies, personal and mobile communications systems have requirements for small, lightweight, low cost, high performance, highly reliable circuits and components for military peculiar applications. Tactical antennas are needed which are capable of supporting multifunctional military communications systems and special purpose military applications. Research is sought in the following general technical areas: millimeter wave/microwave integration, optical control of millimeter waves/microwaves, micromachining of RF and microwave components, propagation and scattering effects on Digital Battlefield communications and radar systems, and tactical HF/VHF/UHF antennas. (Contact: Dr. James Harvey, (919) 549-4244)

Integration technologies provide mm-wave/microwave circuits at small size, light weight, low cost, and high reliability. Novel techniques for integrating circuits are of special interest at higher frequencies, in the mm-wave regime, in order to overcome loss, coupling, and spurious radiation problems. Hybrid techniques which combine high performance from component optimization with low fabrication cost due to compatibility with high volume production processes are needed at mm-wave frequencies and at mobile communications net wave frequencies. Higher levels of integration into chips, modules, and packages present special problems at higher RF frequencies. Dense integration techniques, including 3 dimensional integration, must be developed. Thermal effects must be analyzed and minimized. Innovative approaches such as micromachining can provide significant advantages for circuit integration and the production and integration of passive components. Efficient power and signal combining techniques for RF frequencies, such as quasi-optical combining schemes, are needed. Innovative approaches to millimeter wave antennas are needed to develop antennas and antenna arrays with low losses and high efficiency. At millimeter wave frequencies antennas and antenna arrays tend to become part of the integrated circuit. Active antennas can increase functionality, compactness, and efficiency, and can introduce nonlinearity in the antenna for new applications such as phase conjugation. Special applications, such as conformal arrays for mounting on vehicle surfaces, can place physical limitations on size and shape. Some applications require very broadband or multiband operation. Adaptive antennas require the ability to switch in space and spectrum. (Contact: Dr. James Harvey, (919) 549-4244)

Optically controlled mm-wave and microwave devices and circuits have significant potential application in communications and radar systems, particularly mobile systems. Of particular interest are methodologies for integrated systems generating the final RF signal using an optical heterodyne principle. Sources of coherent optical signals for the heterodyne process are needed, for example phase locked DFB or DBR semiconductor lasers, modelocked semiconductor laser pulses, or double sideband suppressed carrier semiconductor laser systems. Low loss splitters with integral semiconductor amplifiers are needed. Control of polarization during the splitting and amplification processes are important. Novel approaches are sought, such as self focusing multimode waveguide. OEIC's employing phase and amplitude modulation for beam forming are necessary, with polarization modes affected differentially. Fast optical detectors for frequencies up to 60 GHz and above, which can still handle high optical powers are required. Alternative approaches to direct detection, such as optical injection locking should be considered. Advances in the technologies for such components as single sideband optical modulators may provide alternative approaches. Modeling and simulation techniques for the optical interactions in devices and the optical propagation through complex optical structures are needed. Of interest are simulation approaches leading to efficient design methodologies and CAD packages. Efficient optical integration of the components is a special problem. Technologies which foster monolithic or near monolithic electrical and optical integration of special interest. Efficient integration of the optoelectronic components with RF antenna structures is an important consideration. (Contact: Dr. James Harvey, (919) 549-4244)

Electromagnetic analysis, simulation, and modeling are performed for several reasons. Quantitative answers can be obtained for a specific physical problem or circuit configuration, yielding qualitative understanding of a class of problems. The analysis is needed to guide experimental research and to place experimental results in perspective. Systems development decisions are guided by EM analysis of circuits, systems, packages, antennas, and propagation effects. Detailed analysis or modeling is used to design specific systems applications and it supports the optimization processes for CAD techniques. Of special interest is the simulation of integrated circuits and modules as the levels of integration become higher and higher, as the circuits become more dense and more complex, and as new circuit types such as leaky wave, quasi-optical, and active antennas must be addressed. The coupling of radiation into and out of complex structures is a problem of special interest. New analysis concepts, techniques, and methodologies are needed for increasingly complex systems. Innovative signal processing techniques are needed for ultra-wideband radar and ground penetrating radar. (Contact: Dr. James Harvey, (919) 549-4244)

Propagation effects have a major impact on communications and radar systems. Propagation losses and fading and delays caused by multiple path reception have a serious frequency dependent effect on communications systems at all frequency bands, including the bands used for military wireless systems. These propagation effects become highly complex in urban and built up terrain or in terrain with heavy foliage. Propagation and scattering effects are very important for radar systems, particularly for the detection of targets in clutter. (Contact: Dr. James Harvey, (919) 549-4244)

Innovative approaches to increasing the performance and decreasing the size and signature of tactical antennas operating in the HF, VHF, UHF, and microwave frequency bands are needed. Designs for multifrequency, multiband operation are of interest. Broad impedance bandwidths and pattern bandwidths are required for spread spectrum systems. Fast frequency switching over a wide band of frequencies is required for frequency hopping systems. Efficient coupling of EM energy into the ground is required for ground penetration radars. Novel ideas for ultra-wideband radar are needed for enhanced performance. (Contact: Dr. James Harvey, (919) 549-4244)

G. Joint Services Electronic Program (JSEP)

The Joint Services Electronics program (JSEP) is a joint undertaking of the Army, Navy, and Air Force to support electronics and electronics related interdisciplinary basic research in universities contributing to the Department of Defense electronics technology base. The research complements in-house and regular contractual research programs of the Services. On a limited basis the JSEP research program may be augmented by Graduate Fellowships awarded to outstanding students at or near the beginning of their JSEP research program.

The broad areas of research in which proposals are desired include quantum electronics, optics, and electro-optics; solid-state electronics and optoelectronics, devices, materials, and integration; electromagnetics, waveguides, propagation, scattering, and antennas; and information electronics, computers, signal processing, communications, circuits, and systems.

Proposals should address the problems to be investigated in the field of proposed research, the approaches to be used, the expected results, the relationship of the proposed research to other active work at the university, the qualifications of the principal investigators, and the cost of the proposed research. Speculative research with high potential-payoff is an important part of the JSEP program. (Contact: Dr. William Sander, (919) 549-4241)

ENGINEERING SCIENCES

Fluid Dynamics

- Vortex-Dominated Flows
- Unsteady Aerodynamics
- Rotorcraft Aeroacoustics

Solid Mechanics

- High Strain Rate Phenomena
- Penetration Mechanics
- Reliability of Structures

Structures and Dynamics

- Structural Dynamics and Simulation
- Air Vehicle Dynamics

Combustion and Propulsion

- Engines
- Gun Propulsion and Hazards

ENGINEERING SCIENCES

I. INTRODUCTION

Research supported in the Engineering Sciences program is concerned with a broad spectrum of fundamental investigations in the disciplines of fluid dynamics, solid mechanics, structures and dynamics, and combustion and propulsion. Though many creative and imaginative studies concentrate on a particular subdiscipline, increasingly, new contributions arise from interdisciplinary approaches such as the coupling between aerodynamics and structures, combustion and fluid dynamics, or solid mechanics and structures as in the structural reliability area. Additionally, several common themes run through much of these four subdisciplines such as active controls and computational mechanics. Research in such areas as these is addressed within the context of the application rather than as a separate subject of study. Fluid dynamics research is primarily concerned with investigations in the areas of vortex-dominated flows, unsteady aerodynamics, and rotorcraft aeroacoustics. Solid mechanics includes a wide array of research areas such as high strain rate phenomena, penetration mechanics, heterogeneous material behavior, and reliability of structures. The structures and dynamics area is focussed on investigations in vehicle structural dynamics and simulation and air vehicle dynamics including rotor aeromechanics. The research program in the combustion and propulsion sciences area is concentrated on processes characteristic of reciprocating (Diesel) and gas turbine engines and gun propulsion and energetic material hazards. The following narrative describes the details of the scope and emphasis in each of these subdisciplinary areas.

II. RESEARCH AREA

A. Fluid Dynamics

Research in fluid dynamics supports the development of improved or new technology for advanced helicopters, small gas turbine engines, maneuverable high-speed missiles and high performance gun-launched projectiles. While basic research studies that address the fundamental flow physics underlying these devices are solicited, innovative research in the specific topical thrust areas listed below is especially encouraged. (Contact: Dr. Thomas L. Doligalski, (919) 549-4251)(e-mail: Tom@aro-emh1.army.mil)

1. Vortex-Dominated Flows

In contrast to fixed-wing aircraft, rotorcraft always operate under the influence of their own wakes. The prediction of rotor performance, vibratory loads, and blade-vortex interaction noise depends strongly on the accurate prediction of the rotor wake, and the prediction methodology of this wake remains one of the major challenges in fluid mechanics. Current CFD approaches are computationally intensive, especially for Eulerian methodologies where the vorticity diffuses numerically through the grid points and makes predication inaccurate. The process by which vorticity is shed by the blade and rolls up to form vortex filaments is not now adequately simulated for rotorcraft load distributions: in fact, under certain flight conditions multiple vortices are observed to form due to negative lift over the blade tip. The application of non-intrusive optical diagnostic techniques should yield new phenomenological understanding for the study of multiple vortices, wake structures and wake development. New numerical algorithms or different techniques to increase accuracy and reduce the computational requirements are required.

This scenario is further complicated when the vortex wake shed from body components interacts with other components: for instance, under hover conditions or in low-speed forward flight the vortex wake shed from the main rotor is frequently observed to convect into the near vicinity of the main fuselage, the empennage, or the tail rotor. This vortex wake is sometimes observed to be ingested into the engine, resulting in performance degradation and/or catastrophic failure. These close vortex/surface encounters can result in a viscous interaction with the vortical boundary-layer fluid formed on solid surfaces, resulting in an apparent "cutting" of the vortex. This "cut" vortex is observed to reconnect on the opposite side of the body. A second example of this type of interaction occurs during the flight of a missile at angle of attack, where the shed forebody vortices can interact with the fins, reducing their effectiveness. The prediction of these complex interactions is not currently feasible, and is necessary in order to improve the design of these devices.

2. Unsteady Aerodynamics

The flowfield around many modern Army weapons systems can be characterized by a high level of unsteady flow, which cannot be adequately predicted by steady or quasi-steady approaches. One classical example of very high Army relevance occurs on the retreating blade of a helicopter rotor, where high angles of attack lead to boundary-layer separation followed by dynamic stall. Mild separation causes increased vibration and reduces performance, while severe dynamic stall leads to unacceptably large vibratory loads and limits forward flight speeds, load and maneuver capabilities. Practical techniques for preventing and controlling separation and stall under realistic flight conditions (full-scale Mach and Reynolds numbers) are required. Improved understanding of the underlying fluid physics obtained using experimental, analytical, and numerical techniques is necessary to produce effective control.

A second example of the importance of unsteady aerodynamics occurs on maneuvering missiles and projectiles. One key difficulty in this area is associated with the vortical flow that occurs with transient high angle-of-attack operation, which can induce a loss of control surface effectiveness due to carryover of the vortical fluid off the forebody. Another key technical problem is the flow separation due to the interaction of the rocket motor of the maneuvering missile with the missile base causing a loss of stability. Additionally, this flow is inherently transient because of the missile maneuverability and requires a time-accurate solution. These conditions require good resolution of the boundary layer which demands computational resources be at or beyond the limits of the state of the art.

3. Rotorcraft Aeroacoustics

Prediction and control of the intense impulsive acoustic field generated by modern rotorcraft are important to the military to reduce this weapon system's detectability. From a civil aviation standpoint, the acoustic signature generated by rotorcraft is *the* major factor limiting the commercial viability of heliports within the national transportation system. These acoustic emissions are primarily generated by three physical mechanisms: (1) blade-vortex interaction (BVI), in which the vortex field generated by a rotorblade comes in close proximity and interacts with a succeeding blade, (2) high-speed impulsive noise, in which the supersonic flow on the rotor blade extends to the far field beyond the rotor tip in a phenomenon known as delocalization, and (3) low-frequency noise, which propagates over a long distance. Due to the nature of the noise characteristics and the advent of advanced computer-based electronic detection systems, this type of noise can be detected far ahead of upcoming rotorcraft. Basic understanding of the noise generating mechanisms, noise propagation characteristics, and passive and active noise control concepts are required.

B. Solid Mechanics

The light, lethal, survivable, CONUS-based modern Army with quick power projection capabilities around the globe has abiding interest in building fixed and mobile assets in the most efficient manner with advanced materials. Weapons, platforms, ammunition, and ground structures are designed with severe weight and volume restrictions. Innovative use of material(s) combinations for specific applications necessitate understanding of the behavior of materials and structures under complex and severe constraints. Solid mechanics provides the link between optimized material properties on the one hand with the desired structural behavior in terms of changes in shapes under specific set of constraints on the other. Complete understanding of the behavior of structures made of advanced materials and quantitative description of their behavior allow predictive capability so necessary for design methodology. In situations which are described as ballistic in nature, the Army faces unique constraints of very high strain rates, large deformations, high pressures, and rapid changes in temperature. Analytical, experimental, and computational techniques are integrated to solve well-formulated problems. Predictive models validated by well characterized experiments are needed to identify controlling parameters at every scale. These models have to be implementable in codes for the analysis of efficiency of the designed hardware in the performance of military missions. Though imaginative and promising research investigations in all these general areas are of interest, innovative research studies in the following specific topical areas are especially encouraged. (Contact: Dr. Kailasam R. Iyer, 919-549-4258)(e-mail: Iyer@aro-emh1.army.mil)

1. High Strain Rate Phenomena

In its many missions, Army hardware is subjected to overwhelming explosive force characterized by shock, high velocity deformation, damage, and failure. Computer codes are developed to model and visualize in three dimensions the performance characteristics of systems for optimization before decisions are made. Study of structural behavior under severe conditions will be facilitated by innovative computational methodologies. The purpose is to understand and model the deformation and fracture of materials under severe loading conditions. This includes high strain rates (up to 10^7 S^{-1}), large strains (up to 500%), high temperatures (up to melting) and high pressures (5 GPa). Constitutive models should be three dimensional and should allow for path dependency. The primary application of these models will be for high velocity impact and explosive detonation computations. Metal forming, machining and other applications are also of interest. Models are required for a wide variety of materials including metals, ceramics, composites, and energetic materials. The models should be physically based and be suitable for incorporation into Lagrangian and Eulerian codes. It is highly desirable (though not necessary) for the models to be incorporated into a code as part of the research.

The role of spatial and temporal heterogeneities in the behavior of materials which are conventionally considered as homogeneous should be explored in terms of evolution of deformation and damage as influenced by the mechanics. Examples include metals and ceramics with evolving microstructure and discrete aspects of the structure of polycrystalline material aggregates. Development of constitutive models for material anisotropy which evolves in concert with deformation and/or damage including effects on material performance at length scales of significance for applications is emphasized. Discrete damage mechanisms (such as voids, shear bands, or microcracks) exhibit cooperative or collective behavior from multiple damage sites, which leads to total failure of material. Particular issues are spacing and distributions of damage sites, evolution and interaction of damage. Consideration of averaging concepts and stochastic aspects of distributed processes occurring at multiple length scales is highly relevant. Non-local effects should be considered in the development of constitutive equations as appropriate.

An important aspect of this area of research is the development of innovative experimental techniques that can be used to generate experimental data for the wide ranges and combinations of strain rates, strains, temperatures and pressures of interest. To the maximum extent possible, these experiments should provide for direct measurement of stresses and other parameters. These new experimental techniques, together with data from existing experimental techniques, should be used to obtain constants for the models and to demonstrate and validate the models. The models should also be validated by computationally simulating tests that are more complex (such as cylinder impact, penetration and/or explosive-metal interaction).

2. Penetration Mechanics

Penetration mechanics is a research topic that integrates fundamental work in finite deformation, high pressure/high rate response, damage and failure mechanics, and computational solid mechanics. The mechanics and modeling of interfaces in particular need better understanding through innovative experimental and theoretical research. High velocity sliding, such as might occur at penetrator/target interface, must be understood on a physical basis. Computational methods for treating discontinuities in a 3D context are required. These methods must concentrate not only on the computational techniques required to track a moving boundary, but also on the relevant physics and mechanics associated with those surfaces. Examples might include boundaries between dissimilar materials, shock fronts, elastic/plastic boundaries, phase boundaries, shear bands and cracks, as well as penetrator/target interfaces. Penetration into brittle materials presents special challenges due to cracking and comminution of material ahead of the penetrator, high speed granular flow of comminuted material, and the mixing of eroded penetrator material and comminuted target material. Ceramics and geologic materials exhibit extreme sensitivity to loading histories, which may manifest in apparent rate dependence of failure strengths and the propagation of failure waves. All of this needs greatly improved understanding, effective modeling, and efficient computational schemes. Penetration into composite materials presents still another set of challenges. Careful experimental techniques are required to delineate the nature, timing, and evolution of damage and failure in composite targets. Analytical models at multiple scales validated by carefully designed experiments are needed. Innovative research of processes and phenomena in materials and structures which can be triggered by impact to absorb energy, deflect penetrators, and/or laterally disperse momentum is encouraged.

3. Reliability of Structures

The combined requirements of high strength and low weight have led to the extensive use of composite materials in numerous applications within the Army. Composites generally consist of two or more components comprising the host, or matrix material, and some type of continuous (fibers) or discontinuous (inclusions) reinforcement. The spatial placement of reinforcement may be random or ideally periodic with a particular symmetry. Structures may be built of laminates of these elements. Mechanical behavior also includes internal stresses generated by temperature change and mismatch in coefficients of thermal expansion. There are continuing technology barriers that need to be overcome if reliable Army structures such as helicopters, ground vehicles, bridges, and weapons systems can be designed, manufactured, and maintained over a long period of time. There is a need for the development of proven analytical, testing, and inspection tools for the evaluation and life extension of existing structures and durability of future Army vehicles and structures. An important development is that Army needs will increasingly dictate the use of lightweight vehicles and structures. Technologies that enhance fundamental understanding of damage initiation and progression, failure mechanisms and life prediction are important thrusts in the reliability of structures. Of special interest to the Army is the thermo-mechanical response at strain rates encountered in high speed impact or explosive loading.

The inelastic response may be the result of plastic deformation and damage of the individual components, or may be due to partial debonding of internal interfaces. It is desired to understand and quantify collective material constitutive behavior, in an average sense, on a spatial scale somewhat larger than the inherent length scale (reinforcement spacing, for example) of the composite, but still smaller than the structural scale in which the composite is being used. Deterministic as well as probabilistic approaches are encouraged. Phenomena of interest are wave propagation, scattering, dispersion, damage evolution, and failure. What is sought is the experimental, analytical, and computational determination of average effects related to internal wave interactions, load transfer, and interfacial damage. Continuum damage functions to describe the spatial and temporal evolution of degradation of strength and stiffness are needed. In addition, there are important issues which relate to the effect of damage on the performance of structures which can be considered as an aspect of structural mechanics.

C. Structures and Dynamics

A significant challenge facing Army laboratory engineers is the determination of the influence of inertial, thermal, electrical, magnetic, impact, damping, and aerodynamic forces on the dynamic response of adaptive armament systems, ground vehicles, rotorcraft, missiles, projectiles, robotic equipment, parachutes, shelters, and bridges. Its resolution is of fundamental importance to the design and construction of affordable, reliable, durable, and maintainable Army equipment with acceptable levels of personnel safety and comfort. Consequently, the U.S. Army Research Office is supporting basic research in these areas, with emphasis on rotorcraft dynamics, the dynamics, control, and simulation of ground vehicles and weapon systems, and the dynamic response of structural components and systems fabricated from advanced composite materials, with or without embedded actuators and sensors. While the consideration of Army relevant, fundamental research proposals on these general topics is encouraged, more specific details of the Program's predominant thrust areas are described in the following paragraphs. (Contact: Dr. Gary Anderson, (919) 549-4317, or e-mail: Anderson@aro-emh1.army.mil)

1. Structural Dynamics and Simulation

Numerous large and complex mechanical systems used by or for the Army consist of interconnected multi-body structures, e.g., wheeled/tracked military ground vehicles, rotorcraft, weapon systems, robotic equipment, etc. To design such structures efficiently and effectively, kinematic and dynamic simulations of flexible multi-body systems based on constrained non-linear dynamics are required. Research in computational dynamics, inverse dynamics, augmented Lagrangian methods, etc. for constrained mechanical systems is needed to furnish some of the tools required to develop more robust, numerically efficient, and faster than real time simulators. Since material and external damping significantly influence the dynamic response of a composite structure, there is a need to derive and validate experimentally new modeling methods for viscoelastic and other types of damping mechanisms. These techniques must capture the essential physical aspects of the system's response and fit within the structure of modern computational tools well beyond the complex modulus approach. Of particular interest is the development of methodologies for treating elastomeric dampers, e.g., as used in helicopter rotor hubs, to include constitutive equations, hysteresis modeling, and analysis and design. Studies into control techniques based on feedback, feedforward, neural networks, and other approaches and applied to structural components are necessary to increase the performance and efficiency of complex systems functioning under adverse conditions. These could be useful, for example, in improving the firing accuracy of helicopter mounted weapons. In addition, it would be desirable to integrate the problems of structure design, control design, modeling, sensor/actuator selection, and signal processing to produce optimized smart structures constructed from composite materials. Experimental and modeling studies directed to the fundamental understanding of the dynamic response, stability, integrity, and control of smart composite structures endowed with effective actuation and sensing capabilities for potential use in rotorcraft, vehicles, and weapon systems are encouraged. Such structures might include active-passive piezoelectric circuits, active constrained layers, adaptive networks, or novel actuation schemes. Key Army objectives are structural vibration suppression, unsteady load control on helicopter rotor blades, interior and exterior noise reduction in rotorcraft, airfoil shape change, and structural damage detection and mitigation in laminated composites.

Of special Army relevance is the development of high resolution computer based modeling and simulation methodologies for analytical and physical assessment of ground vehicle systems.

Example research requirements would be focused on automatic formulation of the constrained equations of motion, symbolic equation processing, generation of computer codes, computational methods and algorithm optimization for computer architectures, model reduction and error quantification techniques, fluid payload dynamics, optimization, steering, suspension systems and control, weapons positioning control, and non-linear controls.

2. Air Vehicle Dynamics

The successful operation of Army air vehicles, such as rotorcraft, projectiles, missiles, and parachutes depends upon a fundamental understanding of the effects of aerodynamic forces on the vehicle's dynamic aeroelastic response, stability, and control. This reflects the Army's need to extend mathematical modeling procedures and to improve the accuracy of analytical and numerical prediction methods. Currently used methods are incomplete and inaccurate since rotorcraft performance, for example, involves complex, highly interdisciplinary phenomena of aerodynamics, structural dynamics, propulsion system dynamics, and vibration controls. The trend toward the use of bearingless and hingeless rotor blades fabricated with composite flexbeams and spars calls for the development of refined rotor blade modeling schemes and aeroelastic tailoring procedures to exploit the coupling properties of the composite material components. Cost effective textile composites may offer benefits in the design of vehicle structures due to their superior damage tolerance and structural resistance against impact and thermal shock. For example, aeroelastically tailored woven or braided composite box beams could serve in spars in future rotorcraft to produce the bending-twist coupling that enhances their maneuverability. Another important challenge occurs in the need to develop effective and efficient numerical analysis tools that are applicable to moderate to very large systems of differential equations (typically finite element based) featuring periodic coefficients. Such techniques are used to determine solutions for rotorcraft trim, periodic response, and transient response. These problems often include significant non-linearities, periodicity, and unknown parameters that must be chosen to satisfy external constraints. In particular, theoretical, numerical, and experimental methodologies must be devised to further understanding of the non-linear phenomena that may occur in air vehicles, including internal resonance, energy redistribution or transfer, chaos, etc. The non-linear phenomena might involve geometric and material non-linearities in structures or active control of non-linear systems including aerodynamic flows and rotor blades undergoing large deformations. Significant sources of error in current capabilities for predicting rotor dynamics and vibrations are the assumptions of blade-to-blade symmetry and ideal properties of each blade. Since actual rotors do have blade-to-blade asymmetries and non-ideal properties, there is a need to identify and quantify the aspects of non-ideal rotors that affect their dynamic characteristics. Examples of aspects of non-ideal rotors that are of interest to the Army include the effect of blade-to-blade dissimilarities on rotor track and balance, effect of manufacturing or material tolerances on system uncertainties, effects of non-linear drive train dynamics, and effects of battlefield damage to rotors.

Focused research is needed to develop improved computational algorithms for inclusion in rotorcraft comprehensive analysis programs to solve the key component coupling problems. Examples are the interfaces between computational fluid dynamic methods and structural dynamics and the coupling between non-linear controls and structural dynamics. A critical aspect of the accuracy problem is the validation of comprehensive analyses through correlation with rotorcraft flight and wind tunnel test data. To deal with the analysis of large scale systems, techniques of reduced order modeling are desired to facilitate the computation of useful numerical results without seriously compromising their validity. The types of numerical analyses that are needed include (but are not limited to): (1) the determination of the periodic solutions to the equations of motion and of the unknown parameters associated with a specified flight condition, (2) traditional constant and periodic coefficient eigenanalysis procedures as well as computing limit cycles or chaotic behavior of unstable orbits, and (3) determination of optimum design, trim, and control of rotorcraft. Accurate modeling and analysis techniques are also required for investigating the structural performance of pre- and post-failed composite structures in the presence of delaminations to improve the integrity and crashworthiness of air vehicles. Moreover, computationally efficient optimization procedures that include continuous and discrete design variables are of interest in the design of energy absorbing composite structures.

D. COMBUSTION AND PROPULSION

Combustion and propulsion research supports the Army's need for higher performance propulsion systems. These systems must also provide reduced logistics burden (lower fuel/propellant usage) and longer life than today's systems. Fundamental to this area is the extraction of stored, chemical energy and the conversion of that energy into useful work, for vehicle and projectile propulsion. In view of the high temperature and pressure environments encountered in these combustion systems, it is important to advance current understanding of fundamental processes as well as to advance the ability to make accurate, detailed measurements for the understanding of the dominant physical processes. Thus, research in this area is characterized by a focus on high pressure, high temperature combustion processes and on the peculiarities of combustion behavior in systems of Army interest. Though basic research proposals in these general areas will be considered, the main research interests are concentrated on the following thrust areas. (Contact: Dr. David Mann, (919) 549-4249)(e-mail: David@aro-emh1.army.mil)

1. Engines

Ground and air vehicle propulsion relies on reciprocating (Diesel) and gas turbine engines. These engines must be capable of delivering high power with high fuel efficiency. The development of reliable, predictive models for vehicle engines will require advances in understanding fundamental processes, such as turbulent flame structure, heat transfer, and chemical kinetics, as well as understanding and control of the complex chain of fuel injection-atomization-ignition-combustion processes. An additional complication is presented by the high pressure/temperature environment, encountered in Diesel engines (and in liquid propellant guns), which influences liquid behavior and combustion processes at near-critical and super-critical conditions.

The application of miniature smart sensors, actuators and active feedback control systems into advanced engines offers the potential for optimization of performance and minimization of performance degradation over the life of the engine. The result will be an "Intelligent Engine," utilizing either distributed or centralized control to optimize the performance in a "real-time" manner. Examples of the systems which may be incorporated into future engines include active compressor surge and stall control, variable geometry/adaptive reconfiguration, digital fuel control, etc. To affect these advancements, basic research is needed for the development of non-linear engine models, capable of describing engine transient performance and response to conventional and advanced control techniques (e.g. compressor control, variable geometry, etc.). Efforts are also envisioned which will develop the diagnostic and prognostic tools for engine performance monitoring and the means to effect desired changes. Other work will investigate control architectures to determine those best suited to this unique problem.

2. Gun Propulsion and Hazards

Gun propulsion relies on the rapid, controlled release of energy from high energy density, solid and liquid propellants. Creative research approaches leading to reliable, predictive models are needed to advance the development of gun propulsion systems. The unique characteristics exhibited during the ignition and combustion of solid and liquid propellants present formidable challenges. Modern composite, solid propellants are characterized by a complex, multi-dimensional flame structure, with solid, liquid, liquid-gas, and gas phase reaction zones. Liquid propellant combustion is less well understood, but is also characterized by a very complex combustion wave structure, featuring multi-step decomposition, two-phase reacting flow and liquid-gas and gas phase flame zones. For the regenerative, liquid propellant gun, the injection, atomization, ignition and combustion are highly transient processes and, coupled with moving boundaries, present major barriers to analysis. The small scales of the combustion zones, typically on the order of tens of microns, and the high pressures, up to 6000 atmospheres, push the limits of combustion diagnostics. In addition to the "standard" solid and liquid gun systems, there are new, novel systems whose future development requires new directions in combustion research. Among these are: the ram accelerator, featuring high pressure, premixed, supersonic hydrocarbon/oxidizer combustion; the bulk loaded liquid propellant gun, with unique problems of atomization and mixing; and the electrothermal-chemical (ETC) gun, with strong plasma-propellant interactions. An underlying concern with all high energy density systems is the hazard and system vulnerability posed by the propellant. Thus, research is also needed to determine the response of these materials to inadvertent ignition stimuli and factors controlling undesired combustion behavior, such as pressure oscillations.

ENVIRONMENTAL SCIENCES

Terrestrial Sciences
  - Hydrology/Geomorphology
  - Snow, Ice and Frozen Ground

Atmospheric Sciences
  - Atmospheric Boundary Layer Processes
  - Remote Sensing
  - Effects of the Atmosphere on Propagation

ENVIRONMENTAL SCIENCES

I. INTRODUCTION

The Environmental Sciences Program supports fundamental research in the Atmospheric and Terrestrial Sciences, *i.e.* research in the physical sciences of planet Earth (excluding the deep earth, the oceans, and the upper atmosphere). Domains of specific interest range from the shallow subsurface, the land surface and the earth-air interface, to the lower atmosphere and cover surficial environments which vary from the polar regions to the tropics under all weather conditions, both favorable and adverse. Of particular interest are environments of climatic extreme, ranging from alpine and glacial regions to deserts and tropical forests. The ability of the Army to function properly and efficiently in all these environments requires equipment and tactics designed with full knowledge of the potential effects of the environment. Intelligent planning for the battlefield must take advantage of the environment and, therefore, an in-depth understanding of individual environments on a variety of scales and a capability to predict environmental effects and behavior for places and times differing from the here and now is required.

The Army is also committed to be a national leader in environmental and natural resource stewardship for the present and future generations as an integral part of its mission. Responsibilities in this arena include the restoration of sites contaminated through prior Army activities as well as achieving a state of environmentally sustainable operations on all military installations. Cost-effective restoration requires in-depth knowledge and understanding of the physical principles and processes operating in the terrestrial and atmospheric domains across a variety of scales which range from the microscopic to megascopic.

The successful solution of problems in the atmospheric and terrestrial sciences frequently involves a multidisciplinary approach.

II. RESEARCH AREAS

A. Terrestrial Sciences

In general, the Terrestrial Sciences program is concerned with the impact of the natural environment on Army activities, ranging from mobility considerations under combat conditions to the management and stewardship of its installations as regards the impact of Army activities on the natural environment. Primary emphasis is directed toward understanding the behavior of natural materials and the processes operating upon the land surface or within the near-surface environment. The program has two major research areas as described below. (Contact: Dr. Russell S. Harmon, (919) 549-4326)(e-mail: Harmon@aro-emh1.army.mil).

1. Hydrology/Geomorphology

Research in this area is directed predominantly toward the general areas of hydrometeorology, surface hydrology, groundwater flow and transport in both porous and fractured media, and landscape dynamics. Particular emphasis is placed on atmosphere-land interactions at the regional or watershed scale, basin hydrodynamics and hydrologic response, channel network organization and physical/temporal evolution, thresholds of extreme events, and analytical methods for terrain description and landscape modeling. Additionally, advances in our geotechnical knowledge related to the engineering properties and behavior of sedimentary materials (particularly in extreme climatic/environmental settings), the military impact on the landscape (and the environmental consequences thereof), the ability to remotely sense the shallow subsurface, and the understanding of short-term, dynamic coastal processes are also desired. Common issues which transcend all topics are scale dependence and scale invariance, non-linear dynamics, and process interactions, and modeling/simulation and model validation.

2. Snow, Ice, and Frozen Ground

This research field is directed toward the physics, mechanics, and dynamics of snow, ice and frozen ground. More specifically, an enhanced understanding of the fundamental nature, properties, and behavior of these materials at a variety of scales is required. In the case of ice, the molecular and physical properties of surface ice and ice adhesion and the role of time and temperature on the strength and deformation behavior of freshwater ice (specifically deformation in the ductile regime at high strain rates) is of particular concern. Increased emphasis is also directed toward improving fundamental understanding of subsurface flow, transport, and fate of contaminants in cold environments.

B. Atmospheric Sciences

The Atmospheric Sciences Program is primarily, but not exclusively, concerned with the properties and processes of the atmospheric boundary layer (ABL) where most Army activities are concentrated. The research may have future impact on the field operations of the Army, but may also be concerned with the training of soldiers and design, test, evaluation or operation of weapon systems.

The research program is divided into three major research areas. In all areas, the research should be directed at posing testable hypotheses then planning experiments and analysis of the data to perform the test. The objective should be the development of first-principle-based predictive models, using readily determined physically realizable parameters. (Contact: Dr. Walter D. Bach, Jr., (919) 549-4247)(e-mail: Bach@aro-emh1.army.mil)

1. Atmospheric Boundary Layer Processes

Research efforts concentrate on increasing Army knowledge of atmospheric processes in the atmospheric boundary layer at the engagement scale of the battlefield (horizontal distances to 20 km, resolutions at 10's of meters). A principal research interest is in understanding the physical processes of dispersion of materials in heterogeneous surface conditions (elevation, slope, vegetation, moisture). All stability classes are of interest, but new emphasis is given to increased understanding of stable boundary layer processes. Two areas of continued interest are in understanding the processes of the life cycle of natural fogs and the assimilation of atmospheric information in data denied areas.

Research approaches may use one or more of the following: theoretical development, numerical experiments, numerical simulations of field observations, or analyses of remotely sensed data. The research efforts are expected to lead to improved models for visualization and field use.

2. Remote Sensing

Comprehensive measurements (direct or indirect) of wind velocity, temperature, and moisture at their scales of variability in the atmospheric boundary layer are essential for advancing understanding of ABL processes affecting Army operations and systems. The variables should be measured in space and time to clearly define the evolution of three-dimensional physical processes within an ABL volume. Such measurement programs should highlight both the instrumentation development and the interpretation of the physical processes.

3. Effects of the Atmosphere on Propagation

Active and passive electromagnetic systems operating at wave lengths ranging from centimeters to the ultra-violet are limited by weather and dirty battlefield conditions. Propagation effects of interest include absorption and scattering by turbid and turbulent atmospheres and the consequences of the atmosphere on the mutual coherence function and on target/background contrast.

Reflection/scatter and backscatter from natural land surfaces at millimeter wave lengths is of interest, but decreasing emphasis. The dependence on wave length, incident and received polarizations, angle of incidence, bistatic scattering angle and the size and nature of the scattering area should be clearly determined.

Atmospheric effects on acoustic propagation in the heterogeneous boundary layer are of increasing interest because of their importance in prediction of performance of battlefield acoustic sensors, mission planning, and environmental impact on communities. The coupling of sound propagation with the basic state of the atmosphere as well as the effects of terrain and turbulence, also provide a means to remotely sense the atmospheric conditions. As a result, research is required to improve acoustic propagation models to assess sensor performance, environmental effects and atmospheric conditions.

MATERIALS SCIENCE

Degradation, Reactivity and Protection of Materials

Mechanical Behavior of Materials

Synthesis and Processing of Materials

Physical Behavior of Materials

MATERIALS SCIENCE

I. INTRODUCTION

The objective of research supported by the Materials Science Division is to discover the fundamental relationships that connect chemical composition, atomic and microscopic structure, as well as processing history with the resultant properties of materials. The work, although basic in nature, is focussed on those materials, materials processes, and properties that either improve the performance, increase the reliability or reduce the cost of Army systems. With the need for lighter weight, higher performance and more affordable systems, a broad spectrum of advanced materials and materials processing options must be explored. Fundamental studies are required to design and promote development of new polymers, ceramics, metals, and all classes of composites and multicomponent or hybrid systems including nano-scale materials, electro-optic materials, and semiconductors. Research on synthesis and processing technology to enhance and ensure uniformly improved properties and provide materials which are environmentally acceptable and economically viable is of particular interest. Fundamental studies aimed at understanding and improving the behavior of materials exposed to severe mechanical loading and/or high pressure/temperature degradative environments are a special priority. Fundamentally new materials characterization techniques (destructive and non-destructive) based on novel applications of known physicochemical principles which can predict or simulate performance of advanced materials and materials processes in situ are also of interest. Proposals which seek to tabulate physical, mechanical and chemical data without understanding underlying principles will receive a low priority. Only when research provides adequate knowledge about the constitution of materials and their response to the variety of environments encountered during manufacture and service can the scientific design of new materials suitable for Army needs be successful.

II. RESEARCH AREAS

Individual work units are organized into the following subfields:

A. Degradation, Reactivity and Protection of Materials

The program in Degradation, Reactivity, and Protection investigates surface engineering as related to materials modification, processing and the reliability of Army systems in service. It includes non-destructive characterization approaches for in-situ monitoring of materials processing and materials performance over the service life cycle. Principal emphasis is on surface/interface control through ion and beam modification techniques; studies of transport/diffusion behavior; surface characterization; and synthesis of novel degradation-resistant coatings and/or ultrahigh strength nanolaminates and refractory materials. Experimental and theoretical approaches are considered that provide for characterization of surfaces and interfaces; surface and near-surface modification; process/materials characterization as this relates to the structure, wear and environmental resistance of coatings and lubricants;

adhesion; spectroscopic and chemical analysis of low level hydrogen; solid state corrosion inhibitor and hydrophobic coatings; smart materials concepts for degradation mitigation. New physicochemical phenomena that underlie nondestructive characterization of materials during processing and in-service life assessment are also of interest. (Contact: Dr. Robert R. Reeber, (919) 549-4318)(e-mail: Reeber@aro-emh1.army.mil)

B. Mechanical Behavior of Materials

The program on Mechanical Behavior of Materials addresses the fundamental relationships between the structure of materials and their mechanical properties as influenced by composition, environment, loading rate and stress state. Major thrusts include new strengthening, plasticity and toughening mechanisms; mechanical behavior under conditions of large strains (several hundred percent and high strain rates (10^3-10^6/sec); the effects of processing procedures to reduce inherent variations in mechanical properties of materials; and fundamentals of interface behavior in composites at the molecular and nanometer scale. Other important interests seek new knowledge about fundamental deformation processes including shock deformation, fracture, fatigue, creep, transformation toughening, adiabatic shear localization and superplasticity. Studies of mechanical behavior of homogeneous and heterogeneous materials to formulate micromechanics-based quantitative relations that describe flow, failure modes, and failure criteria which can be incorporated into codes are sought. The objectives are new materials with improved mechanical properties to provide enhanced structural integrity and vehicular/soldier ballistic protection, and quantitative models capable of predicting impending materials failure and remaining useful life. Additional interests include fundamental investigations on "smart" materials, biomimetic materials and hierarchical materials for improved mechanical behavior and reliability. (Contact: Dr. Wilbur C. Simmons, (919) 549-4329)(e-mail: Wsimmons@aro-emh1.army.mil)

C. Synthesis and Processing of Materials

The program on Synthesis and Processing of Materials focuses on the use of innovative approaches to process high performance materials reliably and at lower costs. Emphasis is placed on the development of new materials with improved microstructure, constitution and properties. Research interests include studies to understand the influence of fundamental parameters on phase formation, microstructural evolution and the resulting properties. Trends in this subfield include non-equilibrium materials (i.e., rapid solidification, nanoscale structures); powder synthesis and consolidation; novel processing of ceramics, polymers and composites; welding and joining including composite materials; elastomers; adhesive fibers and fabrics; and utilization of microstructural, compositional or other unique signatures which may provide non-destructive in situ feedback process control to enhance product reproducibility and quality. Supercritical fluid, shock-induced chemical processing and other innovative approaches for processing materials are also of interest. (Contact: Dr. Edward S. Chen, (919) 549-4325) (e-mail: Chen@aro-emh1.army.mil)

D. Physical Behavior of Materials

The program of Physical Behavior of Materials seeks research directed at providing an improved understanding of the fundamental mechanisms and key materials and processing variables that determine the electronic, magnetic and optical (EMO) properties of materials and affect the reliability of EMO devices. Emphasis is on research that will facilitate the nanostructuring of materials to realize the materials-by-design concept where new and unique materials are constructed on the atomic scale with application-specific properties. This includes research on understanding the underlying thermodynamic and kinetic principles that control the evolution of microstructures; understanding the mechanisms whereby the microstructure affects the physical properties of materials; and developing insight and methodologies for the beneficial utilization and manipulation of defects and microstructure to improve material performance. Major trends in this subfield include: 1) Electronic materials - materials for microelectronics and packaging; fabrication and processing of semiconductors, interconnects and device structures; and the characterization and control of trace impurities, defects and interfaces in semiconductors; 2) Magnetic materials - permanent magnets, soft magnets, and materials for high frequency applications; processing of low-cost, high performance magnetic materials; and fundamental studies on magnetic coercivity; and 3) Optical materials - materials and processing methods for detectors, lasers, nonlinear optical materials, gradient index optics, and optical windows and coatings. Research to improve the long-term stability of EMO materials, develop multifunctional or smart EMO materials, and develop low observable materials is also being sought. (Contact: Dr. John T. Prater, (919) 549-4259)(e-mail: Prater@aro-emh1.army.mil)

Other important areas of interest include new approaches for materials processing, new composite formulations and surface treatments that minimize environmental impacts; and novel composite concepts, including multifunctional materials. Finally, there is general interest in identifying basic research in the area of manufacturing science, which will address fundamental issues related to the reliability and costs (including environmental) associated with the production and long-term operation of Army systems. The foregoing areas of research are not intended to reflect all of the activities of the Materials Science Division. We are always interested in new ideas and cross disciplinary concepts in materials science which may have future applications for the Army. For further information, contact the most appropriate subfield manager.

MATHEMATICAL AND COMPUTER SCIENCES

Applied Analysis and Physical Mathematics
- Mathematical Modeling and Analysis for Advanced Materials
- Fluid Flow
- Nonlinear Dynamics

Numerical Methods and Optimization
- Numerical Methods
- Optimization

Stochastic Analysis, Applied Probability and Statistics
- Stochastic Analysis and Applied Probability
- Statistical Methods

Systems and Control
- Mathematical System Theory and Control Theory
- Foundations of Intelligent Control Systems

Software and Knowledge-Based Systems
- Software Prototyping, Development and Evolution
- Formal Methods for Software Engineering
- Knowledgebase/Database Science
- Natural Language Processing

Discrete Mathematics and Computer Science
- Discrete Mathematics
- Theoretical Computer Science

THE MATHEMATICAL AND COMPUTER SCIENCES

I. INTRODUCTION

Mathematical and computational methods pervade research, development, testing, and evaluation problems encountered by the Army. Furthermore, increasing demands are being placed on research in the mathematical and computer sciences because of their fundamental role in the analysis and modeling issues that arise in military science, engineering and operations. Although these problems are often and quite naturally stated in terms of their system or operational implementation, their solutions are usually dependent on a number of mathematical and computer science subdisciplines. For example, some promising approaches to computer vision for automatic target recognition (ATR) require research in a wide range of areas including constructive geometry, numerical methods for stochastic differential equations, Bayesian statistics, tree structured methods in statistics, probabilistic algorithms, and distributed parallel computation. Another example is furnished by simulation. Here improvements depend on a large number of research areas including large scale scientific computing and real time computing for embedded systems. Similarly, recent research on dynamical systems, control theory, logic and concurrency is being applied to the extraction and verification of digital control programs for continuous systems.

In this announcement, Army areas of interest will be described to the potential researcher and user mainly by means of research topics within mathematics and computer science. This procedure has the benefit that our program managers can amplify the worth of their programs by funding research topics that have impact on many different problems.

To be able to respond to the increasing demands on the mathematical and computer sciences, the Army Research Office attempts systematically to advance fundamental knowledge that focuses on the needs of the Army. To accomplish this objective, the Division supports extramural basic research in the following six areas:

- Applied Analysis and Physical Mathematics
- Numerical Methods and Optimization
- Stochastic Analysis, Applied Probability and Statistics
- Systems and Control
- Software and Knowledge-Based Systems
- Discrete Mathematics and Computer Science

Each of these six areas is represented by a program. The research supported by the Division does not cover all or even the majority of topics in these six areas. Rather, it covers only certain subareas that are of strategic importance for the Army. Programs typically have two to four foci. There are unavoidable overlaps between programs. The subdisciplinary boundaries within the Division and the disciplinary boundaries in the Army Research Office are not rigidly drawn and there is strong interest in and appreciation for multidisciplinary research in which the mathematical and computer sciences play a major role.

In the following section, the current foci of the six programs are described. For information on the overall scope of the mathematical and computer sciences programs, contact the Director of the Mathematical and Computer Sciences Division, Dr. Jagdish Chandra (919) 549-4254 (e-mail: Chandra@aro-emh1.army.mil).

II. RESEARCH AREAS

A. Applied Analysis and Physical Mathematics

Currently, the foci of the program are in mathematical modeling and analysis for nonlinear ordinary and partial differential, difference, and integral equations for advanced materials, fluid flow (including reactive flow) and nonlinear dynamics. For information on the Applied Analysis and Physical Mathematics Program, contact the program manager, Dr. John Lavery, (919) 549-4253 (e-mail: Lavery@aro-emh1.army.mil).

1. Mathematical Modeling and Analysis for Advanced Materials

Mathematical research oriented toward optimizing properties or performance characteristics of highly nonlinear materials, including "smart" materials and advanced composites, is an area of great interest to the Army. In seeking to understand the relationship between the microscopic and macroscopic length scales of these materials, fundamental issues arise in functional analytical characterization, homogenization, motion of phase boundaries, nonconvex energy functionals and weak convergence. Work on the fundamental level of basic equations and constitutive laws is of interest. Analyzing mathematically and physically consistent models of materials that take into account solid-state diffusion, phase transformation, precipitation, corrosion, impurity segregation, and mechanical relaxation is important for determining properties of composites and for optimizing desirable properties. For material fracture/failure models and shear bands in plastic deformation, interest is in the study of nonlinear equations in complex geometries with emphasis on analytical and approximate methods for multidimensional, time-dependent, nonlinear partial differential equations.

2. Fluid Flow

Research on vortices, vortex motion, turbulence and turbulent diffusion is critical for characterization and optimization of air flow around rotors and of combustion, detonation and explosion. Research on multi-phase flows that occur in Army operations is important. The program is interested in rigorous asymptotic analysis of kinetic models (Euler and Navier-Stokes equations) and in further study of fundamental issues in kinetic theory. Proof of global existence of solutions is of importance because the lack of global existence may point to inadequacies in the model. Refined analysis that results in creation of improved computational procedures is of great interest. In all of this work, comparison with field/experimental data is important.

3. Nonlinear Dynamics

The interests in this area are in optics, dielectrics, electromechanics and other nonlinear phenomena/systems. Analysis that leads to improved procedures for activation and interrogation of nonlinear sensors is of importance. Nonlinear dispersive wave motion is a central issue in fiber-optical transmission and is of importance in the electron flow in submicron semiconductor devices. Support of Army interests in the soldier as a system may require the creation of physics-based mathematical models of human dynamics in a variety of environments.

B. Numerical Methods and Optimization

The Numerical Methods and Optimization Program supports Army needs in producing faster, more stable and accurate solutions to relevant problems in the physical sciences and in operations. For information on the Numerical Methods and Optimization Program, contact the program manager (acting), Dr. John Lavery, (919) 549-4253 (e-mail: Lavery@aro-emh1.army.mil).

1. Numerical Methods

The areas of interest in numerical methods include methods for efficient numerical solution of nonlinear partial differential equations (both time-dependent and steady state), including adaptive finite difference and finite element methods, methods for shock phenomena, methods for the solution of implicit and constrained ordinary and partial differential systems, parallel techniques for linear algebra problems arising from the discretization of continuous models and parallel techniques for calculation of eigenvalues arising in the analysis of large structures. Also of interest are approximation techniques for data and surface analysis. Algorithms for penetration mechanics based on improved physics models are important. New computational procedures for acceleration (shock-wave) induced mixing are needed for enhanced understanding of detonation. Simulations of fluid-structure interaction and behavior of flexible structures, including ram-air parachutes, are required.

2. Optimization

Integer programming, mixed integer programming and nonlinear optimization, especially for large-scale problems, are important for C^3 applications, vulnerability analysis, logistics, resource management and design of materials (molecular chemistry). Specific topics of interest include interior-point trust-region approaches to nonlinearly constrained optimization, limited-memory approaches for large-scale optimization, and convergence of optimization methods for singular problems. Parallel computational methods for molecular dynamics with hundreds of millions of particles, needed for design of new materials, are important. Design of fast algorithms for distributed real-time management of communication networks, where not all of the information is known in advance, is important. How to use combinatorial or other structure to increase the efficiency of the optimization procedure and reduction of sequential and parallel complexity are issues of direct interest. Finally, design of efficient approximation algorithms for the many cases when there is no need to have an exact solution is an area that can have large payoff for the Army.

C. Stochastic Analysis, Applied Probability and Statistics

The Stochastic Analysis, Applied Probability and Statistics Program supports critical Army needs in decision making under uncertainty. For information on this program, contact the main office of the Mathematical and Computer Sciences Division at (919) 549-4321 (e-mail: Math@aro-emh1.army.mil) and ask for the program manager.

1. Stochastic Analysis and Applied Probability

Army R&D programs directed toward system design, development, testing and evaluation problems generate a need for research in the field of stochastic processes, including stochastic differential equations. Special emphasis is given to research into methods for the analysis of observations from phenomena modeled by such processes and to numerical methods for stochastic (partial) differential equations. Research areas of importance to the Army in probability and its applications include interacting particle systems, probabilistic algorithms, stochastic control, large deviations, simulation methodology, spatial processes and image analysis. There is interest in infinite-dimensional processes where the time parameter can be multidimensional. Ideas are needed from Markov random fields, renormalization of the state space, scaling of time, nonlinear stochastic analysis and infinite-dimensional stochastic differential equations. The techniques required include Brownian flows, infinite-dimensional stochastic processes driven by Poisson noise and Levy noise, stochastic differential equations and large deviations in queuing theory.

2. Statistical Methods

There is great interest in statistical methods for very large data sets or very small amounts of data sampled from nonstandard, poorly understood distributions. Understanding of physical processes should be combined with statistical theory. In order to extract more information out of less data, improved methods for combining information from disparate tests are needed. Statistical procedures and theory, including semimartingale theory, are needed for analysis of data on repair and on repaired items. One needs probabilistic methodology that describes the stochastic nature of growth of cracks in different media and associated statistical analysis. Integration of statistical procedures with scientific and engineering information about failure mechanisms is important. Spatial point processes motivated by detecting mine fields in the presence of clutter are of importance for Army operations. More research is required in multiple statistical areas including Bayesian methods, Markov random models, cluster analysis, change point methods and Markov chain Monte Carlo methods. It is important to bring novel statistical thinking into resource management and optimization in very large networks, including communication networks.

D. Systems and Control

The Systems and Control Program is concerned with modeling, analysis and design of complex real-time systems, especially as they relate to Army problems in distributed command, control, and communications and in guidance and control of complex semi-automated and automated systems. The program invests in mathematical system theory, control theory and foundations of intelligent control systems. For information on the Systems and Control Program, contact the program manager, Dr. Linda Bushnell, (919) 549-4319 (e-mail: Bushnell@aro-emh1.army.mil).

1. Mathematical System Theory and Control Theory

Topics of interest include control in the presence of measurement and model uncertainties, geometric theory of control, robust and adaptive control for multivariable and nonlinear systems, synthesis of time and frequency domain issues in infinite dimensions, system identification and its relation to adaptive control, and computational issues related to the design and implementation of real-time control systems. Some practical issues of interest in control theory include hybrid (that is, mixed continuous and discrete time) control, control for smart structures, telerobotics and micromachines, control issues in wireless communication systems, visual tracking, parallel computing and other computational issues. Some theoretical issues of interest in control theory include H^∞ control, adaptive and optimal control, relaxed optimal control, stochastic control, nonlinear control, nonholonomic control, control based on the differential geometry of manifolds and the use of exterior differential systems in control theory.

2. Foundations of Intelligent Control Systems

The fundamental concept of a system that can process artificially sensed information, make optimal decisions based on this information and well-defined objectives and translate those decisions into actions is a guiding and unifying theme for basic research in all major aspects of this subarea. Research of interest includes understanding of discrete event dynamical systems (DEDS), hybrid systems and distributed communication and control. Research on novel modeling and computational paradigms for large intelligent control systems is needed. Intelligent control is the avenue by which regulatory control systems will be expanded to more general functions of decision making, goal selection, mode switching, assistance to human operators, scenario identification, and system adaptation. We are interested in performance and robustness issues and in hierarchical frameworks for intelligent control systems.

E. Software and Knowledge-Based Systems

The program in software and knowledge-based systems (SKBS) addresses the theoretical bases for the analysis, design, development, and evolution of advanced information-based systems that enable significant improvements in state-of-the-art engineering for software, software-based applications (including modeling and simulation), machine learning, knowledge acquisition/representation/synthesis, and knowledgebases/databases. Currently, the research supported by the program is in software prototyping, development and evolution, formal methods for software engineering, knowledgebase/database sciences and natural language processing. For information on the SKBS Program, contact the program manager, Dr. David Hislop, (919) 549-4255 (e-mail: Hislop@aro-emh1.army.mil).

1. Software Prototyping, Development and Evolution

Software prototyping, development and evolution require significant investigation into iterative/adaptive graphically driven interfaces, software generation, evolution and reuse, software system simulation, distributed software change/evolution, software engineering in domain-specific architectures, tools and tool set integration, software system documentation, and needs for testing, validation and verification. In addition, significant advances in formal methods, the interests in which are described in the next subsection, are required.

2. Formal Methods for Software Engineering

The interests in this subarea include global dependencies in software development, the maintenance of these dependencies as software evolves, the interactions among different parts of the process and compatible models for solutions to different parts of the problem. The SKBS Program is interested in research on small-, large- and huge-grain formal methods and software languages, including specification, programming and interface languages. Finally, there is interest in research on real-time software. This research involves the investigation of formal frameworks, deductive methods and tools for the implementation of provably correct (reactive, real-time and hybrid) systems.

3. Knowledgebase/Database Science

Complex reasoning in a real-world environment requires the ability to integrate data from multiple databases (relational databases, object-oriented databases, geographical information systems, etc.) and data structures as well as to adopt and integrate multiple modes of reasoning such as inconsistency, time, planning, scheduling, reasoning under uncertainty, reasoning under incompleteness and reasoning about pictures, images, and sound. Much of the data/information in the world does not (and will not) reside in any conventional database but rather resides in data exchange (DX) formatted files. Only a few DX formats and their application programming interfaces (API) have database management features. This fact along with other characteristics of DX files leads to a number of research issues such as concurrency control, support of behavioral components and query languages. There is interest in these several areas as well as in content-based retrieval, complex reasoning and machine learning.

4. Natural Language Processing

The foci in natural language processing include recognition, understanding and translation of both speech and text. Development of speech understanding systems that combine acoustic parameters with lexical, morphological, syntactic and semantic features and even with domain-specific information related to a particular task or activity is an important goal. Lexical research, that is, identifying the words and phrases that constitute the semantic substance of natural language communication, is central to information access, interface technology and translation. For both speech and text, research in stochastic, rule-based and hybrid approaches is required.

F. Discrete Mathematics and Computer Science

As suggested by the title, the Discrete Mathematics and Computer Science Program supports Army needs in discrete mathematics and theoretical computer science. For information on this program, contact the program manager, Dr. Ming Lin, (919) 549-4256 (e-mail: Mlin@aro-emh1.army.mil).

1. Discrete Mathematics

The interests in discrete mathematics are the development and analysis of solution procedures for discrete problems in computational geometry, computational algebra, logic, network flows, graph theory and combinatorics. Specific areas of emphasis include robust geometric computation, solid modeling, multi-resolution methods, parallel and distributed computing and dynamic and interactive visualization techniques. Other areas of interest include distributed algorithms for network flows, randomization in computing, computational algebraic geometry techniques for solution of polynomial systems, discrete methods for combinatorial optimization, symbolic methods for differential equations, mixed symbolic-numerical methods for applied problems, parallel symbolic sparse matrix methods, and algorithmic methods in symbolic mathematics arising in, for example, automated reasoning systems, mathematical logic and formal language theory.

2. Theoretical Computer Science

The interests in this subarea include fundamental issues in parallel computing such as advanced data structures for parallel architectures, parallel algorithms, languages and compilers, graph theoretic methods applied to parallel and distributed computation and models and algorithms for the control of heterogeneous concurrent computing. Also of interest is research on tools for the development of parallel algorithms and expert systems for computation and visualization of solutions to partial differential equations. Exploring fundamental techniques that optimize I/O communication is a research area of great strategic importance.

CURRENT PRIORITIES

While the above descriptions reflect the current program, there are areas of higher priority among these. This, of course, does not mean that the Mathematical and Computer Sciences Division will exclude other proposals from consideration, but does reflect the Division's intention to develop programs that take into account evolving research trends as well as changing Army needs. Currently, the high priority areas include nonlinear analysis with emphasis on design of advanced materials, novel algorithmic approaches for large-scale scientific computing, fast algorithms for real-time applications, stochastic analysis with emphasis on simulation methodology and numerical methods, symbolic methods, computational geometry with emphasis on interactive simulation and virtual prototyping, intelligent systems, large databases/knowledgebases and software systems.

PHYSICS

Nanotechnology

Obscured Visibility/Automatic Target Acquisition

Optical Warfare

Photonics

Soldier System

PHYSICS

1. INTRODUCTION

The interests of the Army Research Office in physics research are primarily in the following thrust areas: Nanotechnology, Obscured Visibility and Automatic Target Acquisition, Optical Warfare, Photonics, and the Soldier System. Physics disciplines which impact these thrust areas include Atomic, Molecular and Optical physics; Condensed Matter Physics, Cross-Disciplinary topics and Classical Phenomenology. Since they generally have no impact on the thrust areas, there is little interest in Relativity and Gravity Physics, Elementary Particles and Field Physics, Nuclear Physics, Astronomy and Astrophysics. Nevertheless, the possible relevance of topics within these other physics disciplines is not absolutely discounted and discussions of potential exceptions are welcome.

The disciplinary boundaries of the Army Research Office are not sharply drawn as evidenced by the joint support of a number of efforts by the Physics and other divisions. In addition, it is not necessary that a potential chief investigator be associated with a Physics Department to receive support by the Physics Division. For example, most of the ARO investment in laser research is provided by the Physics Division, and the chief investigators within the laser program are typically associated with Departments of Electrical Engineering.

RESEARCH THRUSTS

The following is a description of research objectives within each of the thrust areas. The cognizant Physics Division program managers are listed following each thrust area. In cases where multiple program managers are listed, the appropriate program manager to contact may be determined from their areas of purview: Dr. Bob Guenther, Optics and Classical Phenomenology Physics, (919) 549-4237 (e-mail: Guenther@aro-emh1.army.mil); Dr. Mikael Ciftan, Solid State Physics with emphasis on structural aspects, quantum optics, and a variety of theoretical physics topics (919) 549-4236 (e-mail: Ciftan@aro-emh1.army.mil); Dr. Henry Everitt, Experimental Solid State Physics with emphasis on electrical and optical properties, (919) 549-4369 (e-mail: Everitt@aro-emh1.army.mil); Dr. David Skatrud, Atomic, Molecular and Optical Physics, (919) 549-4313 (e-mail: Skatrud@aro-emh1.army.mil).

A. Nanotechnology

The properties of objects smaller than 1 micron may exhibit phenomena such as quantum confinement, wavelike properties of matter, and quantum superpositions of states. The nanotechnology thrust exploits such phenomena to improve the functionality of various systems. Major areas of interest within the nanotechnology thrust are: (1) Self assembly of novel materials composed of nanometer sized constituents. Additional interests include understanding the evolution of atomic to thin film to bulk behavior, studying the migration, stability, and electronic structure of lattice defects, developing gas-phase diagnostic techniques for materials processing plasmas, and applying atom and molecule cooling, trapping, and interference techniques for materials growth. (2) Investigating the role of carrier coherence as a basis for new device functionality. Additional interests include improving coherence robustness, suppressing coherence noise and chaos, and exploring the fundamentals of quantum computation. (3) Combining high spatial resolution of various nanoprobes with fast temporal or narrow spectral resolution. Development of nanoscale pump-probe techniques and other probes of local behavior is sought. (Contact: Dr. Henry Everitt, Dr. Mikael Ciftan, and Dr. David Skatrud)

B. Obscured Visibility/Automatic Target Acquisition

The Army has the unique requirements to operate on the ground, over relatively short ranges and in conditions of poor visibility and high background clutter. This thrust addresses that need by developing techniques for target acquisition and recognition under conditions of darkness, poor meteorological visibility or obscuration due to dust or aerosols. Enhanced sensors and sources are required, as well as advances in image understanding. Research objectives of current interest include: (1) Investigation of coherent infrared imaging, millimeter wave imaging, multiple wavelength detectors, and temporal imaging. (2) Research which addresses fundamental issues associated with integration of data from multiple sources. (3) Investigation of the fundamental issues of automatic target recognition which will lead to a set of metrics that can be applied to algorithm development in a predictive fashion. (4) Investigation of smart, adaptive, predictive, on focal plane architectures that support automatic target recognition. (Contact: Dr. David Skatrud or Dr. Bob Guenther)

C. Optical Warfare

The use of optical sensors and sources is analogous to the use of radio frequency detectors and sources. Future development of an escalating series of countermeasures and counter-countermeasures is expected. The increased coverage of tunable laser sources in all regions of the spectrum addresses the Army's needs in this area, as does work on nonlinear optical devices. Specific research interests include: (1) Investigation of applications which utilize nonlinear optical processes for sensor protection and optical frequency generation. (2) Development of optical parametric oscillators in new wavelength regions. (3) Development of solid state materials with special reflective, absorptive, and polarization properties. (4) Examination of the use of the developed sources for the remote sensing of chemical agents. (5) Investigation of techniques for masking the characteristics of an interrogating or sensing laser beam. (Contact: Dr. Mikael Ciftan, Dr. Bob Guenther, Dr. David D. Skatrud, or Dr. Henry Everitt)

D. Photonics

The objective of this research thrust is the development of optical subsystems for military applications. Research themes include: (1) Development of materials and techniques for storage and display, optical switching, signal processing, and optical interconnections for micro-electronic systems. (2) Development of new optical designs based upon diffractive optics and gradient index of refractive optics. (3) Investigation of the use of nonlinear optics in integrated optical components. (4) Investigation of the use of photonic band engineering to applications such as single photon communications and highly efficient microlasers. (Contact: Dr. Bob Guenther, Dr. Henry Everitt, or Dr. Mikael Ciftan)

E. Soldier System

Until recently the Army has done very little to enhance the individual soldier's performance capability. Technology has now advanced to the point where personal performance enhancement seems to be within reach. In this new thrust area, the Physics Division seeks to develop devices that would enhance the soldier by providing items such as helmet mounted displays, aids for vision and hearing, environmental sensors and energy generation to power these devices. The limiting component to accomplish these goals is a man-portable energy source to power the technology. Long-term objectives in this thrust area include: (1) Determination of the fundamental limits of energy density and power density as they impact the soldier as a system. (2) Development of compact, efficient, low-signature, soldier-portable power supplies. (3) Evaluation of the use of micro-electromechanical systems to enhance the soldier system. (4) Development of enhanced sensors for the soldier environment and new sensing aids for the soldier such as sensors for detection of chemical and biological agents, and compact sensors to enhance hearing or vision such as uncooled, infrared imagers. (Contact: Dr. Bob Guenther or Dr. David Skatrud)

PART II

SPECIAL PROGRAMS

CONFERENCE AND SYMPOSIA GRANTS

The Army Research Office (ARO) supports conferences and symposia in special areas of science that bring experts together to discuss recent research or education findings or to expose other researchers or advanced graduate students to new research and education techniques. The ARO encourages the convening in the United States of major international conferences and assemblies of international alliances.

Notwithstanding the above, the Department of Defense has imposed certain restrictions on ARO's co-sponsorship of scientific and technical conferences and symposia. Specifically, DoD Instruction 5410.20 prohibits co-sponsorship of conferences and symposia with industrial concerns. Scientific, technical or professional organizations which qualify for tax exemption under the provisions of 26 U.S.C. Sec. 501(c)(3) may receive conference and symposia grants. If you have any questions regarding your organization's eligibility for a conference or symposia grant, you may contact the ARO Legal Office (919-549-4292). Also, conference support requests should be submitted a minimum of six months prior to the date of the conference.

The technical portion of a proposal for support of a conference or symposium should include:

(1) A one page or less summary indicating the objectives of the project.

(2) The topics to be covered.

(3) The location and probable date(s) and why the conference is considered appropriate at the time specified.

(4) An explanation of how the conference will relate to the research interests of the ARO and how it will contribute to the enhancement and improvement of scientific, engineering and/or educational activities as outlined in Part I of the Broad Agency Announcement.

(5) The name of chairperson(s)/principal investigator(s) and his/her biographical information.

(6) A list of proposed participants and the method of announcement or invitation.

The cost portion of the proposal should show:

(1) Total project conference costs by major cost elements.

(2) Anticipated sources of conference income and amount from each.

(3) Anticipated use of funds requested from ARO.

Funds provided by the ARO cannot be used to support participants from communist countries, nor can they be used for payment of any federal government employee for support/subsistence or services in connection with the proposed conference or symposium.

SHORT TERM INNOVATIVE RESEARCH (STIR) PROGRAM

1. Introduction

The objectives of this program are to fund innovative ideas in basic research. Proposed research may be for the continuation of or the natural outgrowth of experimental or theoretical explorations.

2. Eligibility

Research proposals are sought from educational institutions, nonprofit organizations and private industry.

3. Research Sought

Proposals in the amount of $20,000 or less are sought for research in the mathematical, physical, engineering, biological and geosciences as identified in PART I of this BAA.

4. Proposal Preparation

Organizations or institutions should submit proposals that are no more than 20 pages in length, inclusive of the budget, transmittal letter and attachments. Submittal of 10 copies of the proposal is required. Any proposal in excess of 20 pages will not be considered. No brochures or explanatory material should be submitted with the proposal. A one page budget must accompany the proposal.

Proposed research efforts must be "stand alone" and not predicated on the use of any facilities other than those under the direct control of the offeror. Research must be completed within six months of award of the agreement. Extensions of the six month performance period will not be granted.

Proposals should be submitted with a Research Proposal Cover Page similar to ARO Form 51. Limited rights data should be identified as an attachment to the proposal. Otherwise, ARO will assume that the proposal does not contain limited rights data.

No capital equipment may be purchased. Travel costs must not exceed $500. Report preparation costs must not exceed $100. The assessment of indirect costs or fee is unallowable.

The technical investigator(s) should disclose and explain the relevancy of the proposal to the research interests identified in PART I of this BAA.

A brief final technical report must be submitted to ARO within 30 days of completion of the grant or contract period.

Proposals should be mailed to the following address:

Director
U.S. Army Research Office
ATTN: AMXRO-ICA-STIR
4300 South Miami Boulevard
P. O. Box 12211
Research Triangle Park, NC 27709-2211

5. Evaluation Factors

Proposals submitted in response to this BAA's STIR Program will be evaluated using the following criteria:

a. The overall scientific/technical merit of the proposal.

b. The potential contributions of the effort to the Army mission.

c. The offeror's capabilities, related experience, general facilities, or unique combinations of these which are integral factors for achieving the proposal objectives.

d. The offeror's record of past research accomplishments.

Upon receipt, the proposals will be extensively reviewed by highly qualified scientists from within the Government. Proposals not considered to have sufficient scientific merit or relevance to the Army's needs or those in areas for which funds are not expected to be available may be declined without further review.

Each proposal will be evaluated based on the merit and relevance of the specific research proposed as it relates to the overall ARO program rather than against other proposals for research in the same general area.

YOUNG INVESTIGATOR PROGRAM (YIP)

1. Introduction

The objectives of this program are to attract to Army research outstanding young university faculty members, to support their research and to encourage their teaching and research careers.

2. Eligibility

This program is open to U.S. citizens holding tenure-track positions at U.S. universities and colleges who have held their graduate degrees (Ph.D. or equivalent) for fewer than five years at the time of application. Preference will be given to individuals who are not currently principal or co-principal investigators on an ARO agreement.

3. Research Sought

Proposals are invited for that research described in PART I of this BAA. Proposals may be submitted at any time. As is the case for the regular division programs, we strongly encourage informal discussions with the cognizant program manager before submission of a formal proposal. The ARO does not guarantee an award in each topic area. Awards not to exceed $50,000 per year for three years will be made based on research proposals and supporting material. These funds may be used to defray those reasonable costs normally allocable to the research effort (e.g., direct salaries, indirect costs, graduate student support, equipment, supplies, etc.).

4. Proposal Preparation

An individual wishing to apply for a YIP award must submit a research proposal and a supporting letter, each through university officials. Any resulting agreement will be made to the institution, not the investigator. The research proposal should follow the format set forth in PART IV of this BAA. The institutionally approved proposal and letter should be sent to the following:

Director
U.S. Army Research Office
ATTN: AMXRO-ICA-YIP
4300 South Miami Boulevard
P. O. Box 12211
Research Triangle Park, NC 27709-2211

The supporting letter must be from the applicant's Department Chairperson, Dean or other official who speaks for the university regarding support for and commitment to the applicant. Strong university support for the applicant is essential. This support can include the applicant's 9-month academic salary; release time from administrative responsibilities; the purchase of equipment; support for the applicant's graduate students; waiver of indirect costs and so on. It must be clear that the university is making a long-term commitment to the applicant and the research, and the university views the applicant as a potential leading faculty member. The university should make the case that the person being recommended is truly outstanding.

5. Evaluation Factors

The evaluation factors to be used in determining which proposals are selected for funding are described in PART III of this BAA. In addition, proposals submitted for YIP funding will be evaluated based on a long-term commitment by the university to the applicant and the research. Proposals will be selected for award on a competitive basis after a peer or scientific review.

6. Continued Support

Support under the YIP is limited to three years. Upon completion of the 3-year program, young investigators may apply and be considered for continued support in the research areas identified in PART I of this BAA. Decisions about continued funding outside the context of the YIP will be made following a peer or scientific review and a review of ARO's research priorities and the creativity and productivity demonstrated during the previous Young Investigator research program.

HISTORICALLY BLACK COLLEGES AND UNIVERSITIES (HBCUs)AND MINORITY INSTITUTIONS (MIs)

1. Introduction

It is an objective of the Army Research Office to award a fair proportion of its acquisitions to HBCUs and MIs located in the United States. No portion of this BAA will be set aside for HBCU or MI participation due to the impracticality of reserving discrete or severable areas of the research for exclusive competition among the entities.

Before preparation of a proposal, we strongly encourage informal discussion and submission of a brief summary of the proposed research. Key ARO staff members for each area of research interest are identified in PART I of this BAA.

Research collaborations between principal investigators in HBCUs and MIs and scientists in other institutions of higher education (not limited to HBCUs and MIs) are encouraged. Technology sharing and transfer are also encouraged. To this end, we welcome proposals that envision university/industry cooperation.

2. Eligibility

Historically Black Colleges and Universities are those institutions determined by the Secretary of Education to meet the requirements of 34 CFR Section 608.2, and Minority Institutions are those institutions meeting the criteria contained in 10 U.S.C. Section 2323(a)(1)(C), which reads: "minority institutions (as defined in Section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5(3)), which, for the purposes of this section, shall include Hispanic-serving institutions (as defined in section 316(b)(1) of such Act (20 U.S.C. 1059c(b)(1))."

3. Research Sought

Proposals are invited for that research described in PART I of this BAA. The ARO does not guarantee an award in each topic area.

4. Proposal Preparation

Information set forth in PART IV of this BAA shall be used in developing research proposals for funding consideration. Necessary proposal forms are included in PART V.

5. Evaluation Factors

The evaluation factors to be used in determining which proposals are selected for funding are described in PART III of this BAA. Proposals will be selected for award on a competitive basis after a peer or scientific review.

RESEARCH INSTRUMENTATION

1. Introduction

Research instrumentation is designed to improve the capabilities of U.S. universities to conduct research and educate scientists and engineers in areas important to national defense. Of the funds available to acquire research described in Part I of this Broad Agency Announcement (BAA), funds may be provided to purchase instrumentation in support of this research or in the development of new research capabilities.

2. Eligibility and Areas of Interest

To be eligible for an instrumentation award, an offeror must have, at the time of submission, a current grant or contract, and the instrumentation requested must be in support of research being presently carried out. It is highly recommended that potential offerors contact the appropriate ARO staff members identified in Part I of this BAA for advice and assistance before preparation of the instrumentation proposal.

3. Content of Request for Instrumentation

a. Include a concise abstract (approximately 300 words) that describes the instrumentation requested and the research to be supported by that instrumentation.

b. Include a budget that addresses equipment to be purchased and costs, per item and total. Indicate the proposed source of the equipment, the name of a contact at that source and the contact's phone number. The budget should indicate the amount of funds to be contributed by other sources toward the purchase of the instrumentation.

c. Describe how the proposed instrumentation will (i) establish new research capabilities (ii) contribute to research currently proposed to DoD, or (iii) enhance the quality of research currently being funded by ARO.

d. Describe how the proposed instrumentation will interface with or upgrade other research facilities and instrumentation now available.

e. Describe the amounts and sources of ongoing or proposed support for the research to be supported by the instrumentation.

PART III

PROPOSAL

EVALUATION

PROPOSAL EVALUATION

To be eligible for an award of a research agreement, proposals submitted in response to this BAA will be evaluated using the factors listed below (in descending order of importance):

1. The overall scientific and/or technical merits of the proposal.

2. The potential contributions of the effort to the ARO mission and the extent to which the research effort will contribute to balancing the overall ARO research program.

3. The offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

4. The qualifications, capabilities and experience of the proposed principal investigator, team leader, and other key personnel who are critical to achievement of the proposal objectives.

5. The offeror's record of past performance.

6. The reasonableness and realism of proposed costs and fee, if any, and the availability of funds.

Upon receipt of a proposal, the ARO staff will perform an initial review of its scientific merit and potential contribution to the Army mission and also determine if funds are expected to be available for the effort. Proposals not considered to have sufficient scientific merit or relevance to the Army's needs or those in areas for which funds are not expected to be available may be declined without further review.

It is the policy of the ARO to treat all proposals as privileged information prior to award and to disclose the contents only for the purposes of evaluation. Proposals not declined as a result of initial review may be subject to an extensive peer review by highly qualified scientists from within the government and leading scientists and other preeminent experts outside the government. While the offeror may restrict the evaluation to scientists from within the government, to do so may prevent review of the proposal by those most qualified in the field of research covered by the proposal. The offeror must indicate on the appropriate proposal form (ARO Form 52 or 52A) any limitation to be placed on disclosure of information contained in the proposal.

Each proposal will be evaluated based on the scientific merit and military relevance of the specific research proposed as it relates to the overall ARO program rather than against other proposals for research in the same general area.

PART IV

PROPOSAL PREPARATION

PROPOSAL PREPARATION

SECTION 1 - INTRODUCTION

This part is intended to provide information needed for preparing research proposals for submission to the Army Research Office (ARO).

SECTION 2 - GENERAL INFORMATION

PRELIMINARY INQUIRIES:

The ARO receives hundreds of research proposals annually. Because of financial constraints, we are able to provide support for only a limited number of the proposals received. We realize that the preparation of a research proposal often represents a substantial investment of time and effort by the offeror. Therefore, in an attempt to minimize this burden, we strongly encourage organizations and individuals interested in submitting research proposals to make preliminary inquiries as to the general need for the type of research effort contemplated before expending extensive effort in preparing a detailed research proposal or submitting proprietary information.

WHAT PROPOSAL INFORMATION TO INCLUDE:

We prefer that proposal information be provided in two distinct phases:

Phase I (All Offerors Submitting Proposals)

All offerors submitting proposals should provide the technical and budgetary information set forth in Section 3 of this Part. From this information a decision to fund or not to fund the proposed research will be made.

Phase II (Only Offerors Whose Proposals are Accepted for Funding)

For those proposals accepted for funding, we will request at a later date additional information necessary for the award of the research agreement. The information to be requested is identified in Section 4 of this Part and is shown for planning purposes only. Offerors need not include this information as part of their initial proposal submission.

PROCUREMENT INTEGRITY ACT:

For purposes of the Procurement Integrity Act, procurements under this BAA begin when the ARO informs individual competing offerors in writing of receipt of their research proposal.

ELIGIBILITY:

To be eligible for award of a research agreement, a prospective recipient (except other Governments, including state and local Governments) must meet certain minimum standards pertaining to financial resources, ability to comply with the performance schedule, prior record of performance, integrity, organization, experience, operational controls, technical skills, facilities and equipment.

POST EMPLOYMENT CONFLICT OF INTEREST:

There are certain post employment restrictions on former federal officers and employees, including special government employees (Section 207 of Title 18, United States Code). If a prospective offeror believes a conflict of interest may exist, the situation should be discussed with ARO procurement and legal personnel prior to expending time and effort in preparing a proposal.

MILITARY RECRUITING:

This is to notify potential offerors that each grant or cooperative agreement that is awarded under this announcement to an institution of higher education must include the following clause:

> "As a condition of receipt of funds available to the DOD under this award, the recipient agrees that it is not an institution that has a policy of denying, and it is not an institution that effectively prevents, the Secretary of Defense from obtaining for military recruiting purposes: (A) entry to campuses or access to students on campuses; or (B) access to directory information pertaining to students. The recipient is determined, using procedures established by the Secretary of Defense to implement Section 558 of Public Law 103-337 (1994), to be such an institution during the period of performance of this agreement, and therefore to be in breach of this clause, the Government will cease all payments of DOD funds under this agreement and all other DOD grants and cooperative agreements, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award."

If your institution has been identified under the procedures established by the Secretary of Defense to implement Section 558, then: (1) no funds available to DOD may be provided to your institution through any grant, including any existing grant; (2) as a matter of policy, this restriction also applies to any cooperative agreement; and (3) your institution is not eligible to receive a grant or cooperative agreement in response to this solicitation.

This is to notify potential offerors that each contract that is awarded under this announcement to an institution of higher education shall include the following clause: DFARS 252.209-7007 Military Recruiting on Campus (MAR 1995).

DEFINITIONS:

A. Small Business Concern. A concern that is independently owned and operated, organized for profit, is not dominant in the field of operation in which it is bidding on Government contracts, and with its affiliates employs not more than 500 employees.

B. Small Disadvantaged Business Concern. A small business concern which is at least 51 per centum owned by one or more socially and economically disadvantaged individuals; or, in the case of any publicly owned business, at least 51 per centum of the stock of which is owned by one or more socially and economically disadvantaged individuals and whose management and daily business operations are controlled by one or more of such individuals.

C. Historically Black Colleges and Universities. Institutions determined by the Secretary of Education to meet the requirements of 34 CFR Section 608.2.

D. Minority Institution. Institutions defined as those meeting the criteria contained in 10 U.S.C. Section 2323(a)(1)(C), which reads: "minority institutions (as defined in Section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5(3)), which, for the purposes of this section, shall include Hispanic-serving institutions (as defined in Section 316(b)(1) of such Act (20 U.S.C. 1059c(b)(1)."

E. Grant and Cooperative Agreement. A written document showing agreement between the ARO and an eligible recipient by which the ARO agrees to provide the recipient a stated sum of RDTE funds and the recipient agrees to use such funds to perform research identified in an approved proposal of the recipient. The authority for grant and cooperative agreement awards is set forth in 10 U.S.C. 2358. The criteria for using these documents are identified in 31 U.S.C. 6304-6305. Grants and cooperative agreements are governed by the following regulations:

(i) OMB Circular A-110, "Grants and Agreements with Institutions of Higher Education, Hospitals, and other Nonprofit Organizations"

(ii) OMB Circular A-21, "Cost Principles for Educational Institutions"

(iii) OMB Circular A-88, "Indirect Cost Rates, Audit and Audit Follow-up at Educational Institutions"

(iv) OMB Circular A-122, "Cost Principles for Non-Profit Organizations"

Copies of these regulations may be obtained from:

Executive Office of the President
Publications Service
New Executive Office Building
725 17th Street, N.W., Room 2200
Washington, DC 20503

Telephone: (202) 395-7332

F. Research Agreement. As used herein, the term refers to both research contracts, grants and cooperative agreements.

RESTRICTIVE MARKINGS ON PROPOSALS:

Please complete ARO Form 52 or 52A stating your preference for release of information contained in your proposal. A copy of this form is provided in Part V of this BAA.

REPORTS REQUIREMENTS:

The number and types of reports will be specified in the research agreement.

The reports will be prepared and submitted in accordance with the Reporting Instructions of the U.S. Army Research Office which will be provided for the Principal Investigator by the ARO Scientific Officer. Basically, two kinds of reports are desired: "technical progress" reports and "technical" reports. Technical progress reports are due 31 December of each research agreement year. The reports are brief (usually less than two pages) and provide a record of accomplishment and status of the research. Technical reports are classified under four types: manuscripts, reprints, locally-reproduced interim technical reports and final reports. Recipients are required to complete Standard Form 298, Report Documentation Page, for reprints, locally-reproduced interim technical reports and final reports. The delivery of a final report at the conclusion of the agreement is required notwithstanding the fact that the research may be continued under a follow-on agreement.

SUBCONTRACTING:

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. 637(d)), it is the policy of the Government to enable small business concerns to be considered fairly as subcontractors under all research agreements awarded to prime contractors and grantees.

EQUIPMENT:

Title to equipment or other tangible property purchased with contract funds may be vested in nonprofit institutions of higher education or with nonprofit organizations whose primary purpose is the conduct of scientific research. Normally title will vest in the recipient if vesting will facilitate scientific research performed by the institution or organization for the Government. Commercial organizations are expected to possess the necessary plant and equipment to conduct the proposed research.

PROPOSAL PREPARATION AND SUBMISSION:

Proposals may be submitted at any time. In preparing a proposal it is important that the offeror keep in mind the characteristics of a suitable proposal acceptable for formal evaluation. It should include all the information specified in this announcement in order to avoid delays in evaluation.

A proposal for continuation of a given research project will be considered on the same basis as proposals for other new research agreements. The proposal should be submitted sufficiently in advance of the termination of the existing agreement so that if it is accepted, support may be continued without interruption.

Submittal of 20 copies of the proposal is required for proposals submitted to ARO. Each copy must contain any restrictive legends (see guidance provided above).

If the offeror does not have the means for preparing multiple copies, one reproducible copy may be submitted. The proposal should be mailed to:

Director
U.S. Army Research Office
ATTN: AMXRO-ICA
4300 South Miami Boulevard
P. O. Box 12211
Research Triangle Park, NC 27709-2211

UNSUCCESSFUL PROPOSAL DISPOSITION:

Unless noted in an offeror's proposal to the contrary, unsuccessful proposals will be retained for six months from declination and then properly destroyed.

SECTION 3 - CONTENTS OF RESEARCH PROPOSALS (PHASE I)

All offerors preparing research proposals for submission to the ARO should initially submit the following information:

- Cover Page (ARO Form 51)
- Table of Contents
- Statement of Disclosure Preference (ARO Form 52 or 52A)
- Project Abstract
- Technical Proposal (Project Description)
- Biographical Sketches
- Bibliography
- Current and Pending Support
- Facilities, Equipment and Other Resources
- Budget Proposal
- Appendices (if applicable)

COVER PAGE (ARO FORM 51):

See Part V of this BAA for the required Cover Page, ARO Form 51. Should the project be carried out at a branch campus or other component of the submitting organization, that branch campus or component should be identified in the space provided.

The title of the proposed project should be brief, scientifically representative, intelligible to a scientifically literate reader, and suitable for use in the public press.

The proposed duration for which support is requested should be consistent with the nature and complexity of the proposed activity. Awards may be made for periods up to 3 years (1 basic year of performance with two 1-year options). The ARO reserves the right, however, to award contracts, grants and cooperative agreements with shorter or longer periods of performance.

Specification of a desired starting date for the project is important and helpful to ARO staff; however, requested effective dates cannot be guaranteed. Should unusual situations, such as long lead time on procurements, create problems regarding the proposed effective date, the investigator should consult the proposing organization's business office.

Should any of the special aspects apply to a proposal, the appropriate box(es) should be checked.

Proposals must be cleared through the organizational officer having responsibility for Government business relations. One copy of the Cover Page must be signed by an official authorized to commit the organization in business and financial affairs and the Principal Investigator(s). Other copies provided may be reproductions.

TABLE OF CONTENTS:

Part V of this BAA contains the required Table of Contents form. Offerors' proposals should show the location of each section of the proposal as well as major subdivisions of the project description.

STATEMENT OF DISCLOSURE PREFERENCE (ARO FORM 52 OR 52A):

Complete ARO Form 52 (Industrial Contractors) or ARO Form 52A (Educational and NonProfit Organizations) as provided in Part V.

PROJECT ABSTRACT:

The Project Abstract shall include a concise statement of work and basic approaches to be used in the proposed effort. The abstract should include a statement of objectives, methods to be employed and the significance of the proposed effort to the advancement of knowledge.

The abstract should be no longer than one page and be in a form suitable for release under the Freedom of Information Act, 5 U.S.C. 552, as amended. The abstract should indicate the effort intended for each 12-month period of research.

TECHNICAL PROPOSAL (PROJECT DESCRIPTION):

The technical portion of the proposal should be submitted on the form found in Part V of this BAA and shall contain the following:

a. A complete discussion stating the background and objectives of the proposed work, the approaches to be considered and the level of effort to be employed. Include also the nature and extent of the anticipated results and, if known, the manner in which the work will contribute to the accomplishment of the agency's mission.

b. A brief description of your organization. If the offeror has extensive government contracting experience and has previously provided the information to ARO, the information need not be provided again. A statement setting forth this condition should be made.

c. The names of other federal, state, local agencies or other parties receiving the proposal and/or funding the proposed effort. If none, so state. Concurrent or later submission of the proposal to other organizations will not prejudice its review by ARO if we are kept informed of the situation.

d. A statement regarding possible impact, if any, of the proposed effort on the environment considering as a minimum its effect upon water, atmosphere, natural resources, human resources, and any other values.

e. The offeror shall provide a statement regarding the use of Class I ozone-depleting chemicals and substances. If Class I chemicals/substances are to be utilized, a list will be provided as part of the offeror's proposal. If none, so state. Class I chemicals and substances are those found in Appendix A 40 C.F.R. Part 82, Subpart A.

f. The type of support, if any, the offeror requests, e.g., facilities, equipment, materials.

BIOGRAPHICAL SKETCHES:

This section shall contain the biographical sketches of all **key** personnel:

The following information is required:

a. Vitae, listing only academic essentials.

b. List of up to five publications most closely related to the proposed project and up to five other significant publications, including those being printed. Patents, copyrights, or software systems developed may be substituted for publications.

c. List of persons, other than those cited in the publication list, who have collaborated on a project or a book, article, report or paper within the last 48 months; otherwise, state "None."

d. Names of each investigator's own graduate and postdoctoral advisors.

e. A description of any prior Federal employment within one year preceding the date of proposal submission.

The information provided in c. and d. is used to help identify potential conflicts or bias in the selection of reviewers.

For the personnel categories listed below, the proposal may include information on exceptional qualifications of the individuals that merit consideration in the evaluation of the proposal.

a. Postdoctoral associates

b. Other professionals

c. Students (research assistants)

The biographical sketches are limited to three pages per investigator and other individuals that merit consideration. See Part V of this BAA for the appropriate format. This format may be reproduced as needed.

BIBLIOGRAPHY:

A bibliography of pertinent literature is required. Citations must be complete (including full name of authors, title and location in the literature). See Part V of this BAA for the appropriate format.

CURRENT AND PENDING SUPPORT:

Part V of the BAA provides a model format for reporting all current, on-going projects and pending support for proposals, including subsequent funding in the case of continuing award agreements. All project support from whatever source must be listed. The list must include all projects requiring a portion of the Principal Investigator's and other senior personnel's time, even if they receive no salary support from the project(s).

The information should include, as a minimum, (i) the project/proposal title and brief description, (ii) the name and location of the organization or agency presently funding the work or requested to fund such work, (iii) the award amount or annual dollar volume of the effort, (iv) the period of performance, and (v) a breakdown of the time required of the Principal Investigator and/or other senior personnel.

FACILITIES, EQUIPMENT AND OTHER RESOURCES:

The offeror should include in his proposal a listing of facilities and major equipment already available to be used in the performance of the proposed effort.

BUDGET PROPOSAL (including SF 1411 and DD Form 1861):

Each proposal must contain a budget for each year of support requested and a cumulative budget for the full term of requested ARO support. The budget form found in Part V of this BAA may be reproduced as needed. Locally produced versions may be used, but you may not make substitutions in prescribed budget categories nor alter or rearrange the cost categories as they appear on the form. The proposal may request funds under any of the categories listed so long as the item is considered necessary to perform the proposed work and is not precluded by applicable cost principles. In addition to the forms, the budget proposal should include up to five pages of budget justification for each year. A summary budget page should be included. The documentation pages should be titled "Budget Explanation Page" and numbered chronologically starting with the budget form. The need for each item should be explained clearly.

A completed Standard Form 1411 must also be submitted which shows the total estimated cost of the research project. All cost data must be current and complete. Costs proposed must conform to the following principles and procedures:

Educational Institutions: OMB Circular A-21
Nonprofit Organizations: OMB Circular A-122*
Industrial Organizations: Federal Acquisition Regulation (FAR) Part 31
and Defense Federal Acquisition Regulation
Supplement (DFARS) Part 231

*For those nonprofit organizations specifically exempt from the provisions of OMB Circular A-122, FAR Part 31 and DFARS Part 231 shall apply.

The budget(s) must include the following:

a. Direct Labor: Show the current and projected salary amounts in terms of man-hours, man-months or annual salary to be charged by the principal investigator(s), faculty, research associates, postdoctoral associates, graduate and undergraduate students, secretarial, clerical, and other technical personnel either by personnel or position. State the number of man-hours used to calculate a man-mouth or man-year. For proposals from universities, research during the academic term is deemed part of regular academic duties, not an extra function for which additional compensation or compensation at a higher rate is warranted. Consequently, academic-term salaries shall not be augmented either in rate or in total amount for research performed during the academic term. Rates of compensation for research conducted during nonacademic (summer) terms shall not exceed the rate for the academic terms. When part or all of a person's services are to be charged as project costs, it is expected that the person will be relieved of an equal part or all of his or her regular teaching or other obligations. For each person or position, provide the following information:

(1) The basis for the direct labor hours or percentage of effort, e.g., historical hours or estimates.

(2) The basis for the direct labor rates or salaries. Labor costs should be predicated upon current labor rates or salaries. These rates may be adjusted upward for forecast salary or wage cost-of-living increases that will occur during the agreement period. The proposal should separately identify the ratio applied to base salary/wage for cost-of-living adjustments and merit increases. Each must be fully explained.

(3) The portion of time to be devoted to the proposed research, divided between academic and non-academic (summer) terms, when applicable.

(4) The total annual salary charges to the research project.

(5) Information that may affect the salary during the project, such as plans for leave and remuneration while on leave.

b. Fringe Benefits and Indirect Costs (Overhead, General and Administrative and Other): The most recent rates, dates of negotiation, the base(s) and periods to which the rates apply must be disclosed and a statement included to identify whether the proposed rates are provisional or fixed. If the rates have been negotiated by a Government agency, state when and by which agency. **A copy of the negotiation memorandum should be provided.** If negotiated forecast rates do not exist, you must provide sufficient detail to enable the ARO to determine that the costs included in the forecast rate are allocable according to applicable OMB Circulars or FAR/DFARS provisions. Your disclosure should be sufficient to permit a full understanding of the content of the rate(s) and how it was established. As a minimum, the submission should identify:

(1) all individual cost elements included in the forecast rate(s);

(2) bases used to prorate indirect expenses to cost pools, if any;

(3) how the rate(s) was calculated;

(4) distribution basis of the developed rate(s);

(5) bases on which the overhead rate is calculated, such as "salaries and wages" or "total costs"; and

(6) the period of the offeror's fiscal year.

c. Permanent Equipment: If facilities or equipment are required, a justification why this property should be furnished by the Government must be submitted. State the organization's inability or unwillingness to furnish the facilities or equipment. Offerors must provide an itemized list of permanent equipment showing the cost for each item. Permanent equipment is any article of tangible nonexpendable property having a useful life of more than one year and an acquisition cost of $5,000 or more per unit. The basis for the cost of each item of permanent equipment included in the budget must be disclosed, such as:

(1) Vendor Quote: Show name of vendor, number of quotes received and justification if intended award is to other than lowest bidder.

(2) Historical Cost: Identify vendor, date of purchase, and whether or not cost represents lowest bid. Include reason(s) for not soliciting current quotes.

(3) Engineering Estimate: Include rationale for quote and reason for not soliciting current quotes.

If applicable, the following additional information shall be disclosed in the offeror's proposal:

(1) Special test equipment to be fabricated by the awardee for specific research purposes and its cost.

(2) Standard equipment to be acquired and modified to meet specific requirements, including acquisition and modification costs, listed separately.

(3) Existing equipment to be modified to meet specific research requirements, including modification costs. Do not include equipment the organization will purchase with its funds if the equipment will be capitalized for Federal income tax purposes.

The purchase of non-U.S.-manufactured equipment requires special authorization under the Buy American Act. Time required to process such approvals is approximately 90 days.

Proposed permanent equipment purchases during the final year of an award shall be limited and fully justified.

Grants, cooperative agreements or contracts may convey title to the institution for equipment purchased with project funds. At the discretion of the Contracting/Grants Officer, the agreement may provide for retention of the title by the Government or may impose conditions governing the equipment conveyed to the organization. The Government will not convey title to commercial contractors.

NOTE: It is the policy of the Department of Defense that all commercial and nonprofit contractors provide the equipment needed to support proposed research. In those rare cases where specific additional equipment is approved for commercial and nonprofit organizations, such approved cost elements shall be "nonfee-bearing." In addition, commercial contractors are precluded from using contract funds to acquire facilities with a unit acquisition cost of $10,000 or less (see FAR Subpart 45.302-1).

d. Travel: A forecast of travel expenditures (domestic and foreign) that identifies destination and the various cost elements (airfare, mileage, per diem rates, etc.) must be submitted. The costs should be in sufficient detail to determine the reasonableness of such costs. Allowance for air travel normally will not exceed the cost of round-trip, economy air accommodations. Specify the type of travel and its relationship to the research. Requests for domestic travel must not exceed $2,500 per year per principal investigator. Separate, prior approval by ARO is required for all foreign travel (i.e., travel outside the continental U.S., its possessions and Canada). Foreign travel requests must not exceed $1,800 each per year per principal investigator. Special justification will be required for travel requests in excess of the amounts stated above and for travel by individuals other than the principal investigator(s). Additional travel may be requested for travel to Army laboratories and facilities to enhance agreement objectives and to achieve technology transfer.

e. Participant Support Costs: This budget category refers to costs of transportation, per diem, stipends and other related costs for participants or trainees (but not employees) in connection with ARO-sponsored conferences, meetings, symposia, training activities and workshops (See Part III - Special Programs). Generally, indirect costs are not allowed on participant support costs. The number of participants to be supported should be entered in the brackets on the budget form.

f. Materials, Supplies and Consumables: A general description and total estimated cost of expendable equipment and supplies are required. The basis for developing the cost estimate (vendor quotes, invoice prices, engineering estimate, purchase order history, etc.) must be included. If possible, provide a material list.

g. Publication, Documentation, Dissemination: The budget may request funds for the costs of preparing, publishing or otherwise making available to others the findings and products of the work conducted under an ARO agreement, including costs of reports, reprints, page charges, or other journal costs (except costs for prior or early publication); necessary illustrations; cleanup, documentation, storage, and indexing of data and data bases; and development, documentation, and debugging of software.

h. Consultant Costs: The nature of proposed consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate, number of days of expected service and estimated travel and per diem costs.

i. Computer Services: The cost of computer services, including computer-based retrieval of scientific, technical and educational information may be requested. A justification based on the established computer service rates at the proposing organization should be included. The budget also may request costs, which must be shown to be reasonable, for leasing automatic data processing equipment. The purchase of computers or associated hardware and software should be requested as items of equipment.

j. Subcontracts or Subgrants: A precise description of services or materials that are to be awarded by subcontract or subgrant must be provided. For awards totaling $10,000 or more, provide the following specific information:

(1) The identification of the type of award to be used (cost reimbursement, fixed price, etc.).

(2) If known, the identification of the proposed subgrantee or subcontractor and an explanation of why and how the subgrantee or subcontractor was selected or will be selected.

(3) Whether or not the award will be competitive and, if noncompetitive, rationale to justify the absence of competition.

(4) A detailed cost summary.

(5) The offeror's cost or price analysis of the subgrant or subcontract proposed price (applicable only if the award exceeds $1,000,000).

k. Other Direct Costs: Itemize and provide the basis for proposed costs for other anticipated direct costs such as communications, transportation, insurance and rental of equipment other than computer related items. Unusual or expensive items shall be fully explained and justified.

l. Fixed Fee: The fixed fee, if any, which the organization proposes to assess the research project. A claimed Facilities Capital Cost of Money (FCCM) supported by DD Form 1861 is also needed.

APPENDICES:

Some situations require that special information and supporting documents be included in the proposal before funding can be approved. Such information and documentation should be included by appendix to the proposal.

SECTION 4 - CONTRACTUAL INFORMATION TO BE REQUESTED FROM SUCCESSFUL OFFERORS (PHASE II)

Offerors whose proposals are accepted for funding will be contacted before award to provide additional information requested for award, including the following certifications and statements, where applicable. The certifications and statements need not be included in the initial proposal submission.

Contingent Fee Representation and Agreement (FAR 52.203-4)
Certification of Nonsegregated Facilities (FAR 52.222-21)
Previous Contracts and Compliance Reports (FAR 52.222-22)
Affirmative Action Compliance (FAR 52.222-25)
Clean Air and Water Certification (FAR 52.223-1)
Small Business Concern Certification (FAR 52.219-1)
Small Disadvantaged Business Concern Certification (FAR 52.219-2)
Women-Owned Small Business Representation (FAR 52.219-3)
Type of Business Organization (FAR 52.215-6)
Place of Performance (FAR 52.215-20)
Debarment and Suspension Certificate
Cost Accounting Standards Notices and Certification (FAR 52.230-1)
Environmental Impact Statement
Requirement for Access to or Possession of Classified Information
Organizational Conflicts of Interest Statement (FAR 15.505)
Insurance-Immunity from Tort Liability (FAR 52.228-6)
Certification Regarding Lobbying (31 U.S.C. 1352)
Certification Regarding a Drug-Free Workplace (FAR 52.223-5)
Certificate of Procurement Integrity (FAR 52.203-8)

PART V

PROPOSAL FORMS

COVER PAGE FOR PROPOSAL TO THE ARMY RESEARCH OFFICE

SUBMIT 20 COPIES OF PROPOSAL TO:

Director
US Army Research Office
ATTN: AMXRO-ICA
P.O. Box 12211
Research Triangle Park, NC 27709-2211

For Consideration by ARO Organization Unit(s):
(Indicate the most specific unit known, i.e. program, division, etc.)

☐ Biology
☐ Chemistry
☐ Computer Sci.
☐ Electronics
☐ Engineering
☐ Environmental
☐ Materials
☐ Mathematics
☐ Physics

For ARO Use Only

ARO Proposal Number

Employer Identification Number (EIN) or Taxpayer Identification Number (TIN):

Contractor Establishment Code (CEC):
(If known)

Is This Proposal Being Submitted to Another Federal Agency?
YES____ NO____ If YES, List the Agency or Agencies.

Name of Organization to Which Award Should be Made:

Is Applicant Delinquent on any Federal Debt?
☐ Yes (If Yes, Attach Explanation.) ☐ No

Administrative Address of Organization, Including Zip Code:

Organizational Code (If known):

Is Submitting Organization:
(Check All That Apply)
☐ For-Profit: Large Business ☐ Small Business ☐ Disadvantaged Business ☐ Woman-Owned Business ☐ Foreign
☐ Educational Institution: ☐ Historically Black College or University ☐ Minority Institution ☐ Other Non-Profit
☐ State Controlled Institution of Higher Learning

Branch/Campus/Other Component (Where work is performed, if different):

Title of Proposed Project:

Type of Award Requested:
☐ Single Investigator
☐ Young Investigator Program
☐ STIR
☐ Research Instrumentation
☐ HBCU/MI
☐ Other (Specify)

Requested Amount:
$

Proposed Duration (1-60 months):
months

Requested Starting Date:

Proposal Valid Until:
(minimum of 6 months)

Check Appropriate Box(es) If This Proposal Includes Any of the Items Listed Below:

☐ Vertebrate Animals ☐ National Environmental Policy Act ☐ Human Subjects
☐ Proprietary and Privileged Information ☐ Disclosure of Lobbying Activities
☐ Research Involving Genetically Engineered Organisms
☐ Historical Places ☐ Limited Rights Data

PI/PD Department

PI/PD Fax Number

PI/PD Postal Address

Typed Names and Signatures	Telephone Number	Facsimile Number	Electronic Mail Address
PI/PD			
Co-PI/PD			
Administrative Representative Authorized to Conduct Negotiations:			
Primary:			
Alternate:			

Authorized Representative Title:
Typed Name:

Date Signed:
Signature:

ARO Form 51
(Revised June 95)

THIS FORM SUPERSEDES EDITION OF JULY 93 WHICH IS OBSOLETE

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Biographical Sketch	E-1 - E-
Bibliography	F-1 - F-
Current and Pending Support	G-1 - G-
Facilities, Equipment and Other Resources	H-1 - H-
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Contract Facilities Capital Cost of Money (DD Form 1861)	K-1
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List Appendix Items: ____________________

____

____

____

PROTECTION OF PROPRIETARY INFORMATION DURING EVALUATION AND AFTER AWARD

It is the policy of the US Army Research Office to treat all research proposals as privileged information prior to award and to disclose the contents only for purposes of evaluation. Technical evaluation of these proposals normally are made by highly qualified scientists from the Government and leading scientists and other preeminent experts outside the Government to ascertain the merits of the proposal. While you may, if you wish, restrict the evaluation of your proposal to only scientists within the Government, to do so may prevent it from receiving an evaluation by those most qualified in the field of your proposal. Therefore, we ask permission to send your proposal outside of the Government if that is necessary to obtain an unrestricted evaluation by such qualified individuals.

All reviewers are made aware that proposals sent to them shall not be duplicated, used, or disclosed in whole or in part for any purpose other than to evaluate the proposal, without the written permission of the offeror.

You should be aware that despite all precautions, we can protect the confidentiality of proprietary information contained in proposals only to the extent that it is exempt from disclosure under the Freedom of Information Act (FOIA; 5 U.S.C. 552). Generally, Exemption 4 of the FOIA (5 U.S.C. 552(b)(4)) will protect from release information submitted to the Government that constitutes either (1) a trade secret or (2) commercial or financial information which is privileged or confidential. Any such proprietary information contained in your proposal should be marked in accordance with FAR 15.509.

Please complete the following statement indicating your preference for treatment of your proposal during the evaluation phase and, should a grant or contract be awarded, after award.

STATEMENT OF DISCLOSURE PREFERENCE

______________________________ in submitting proposal ______________________________

(Organization) (Title)

______________________________ with ______________________________

(Name)

as Principal Investigator require the following procedure be used during its evaluation:

( ) Permission is hereby granted to the US Army Research Office to evaluate this proposal in accordance with its normal procedures which may include evaluation by evaluators both within and outside the Government with the understanding that written agreement not to disclose the information contained therein shall be obtained from any nongovernment evaluators. Permission to release outside the Government, for evaluation purposes only, those pages of the proposal marked in accordance with FAR 15.509 is hereby granted, except for the following pages or sections: ______________________________

____

( ) Restrict the evaluation of the above proposal to Government personnel only.

To reduce administrative requirements, you may complete the following information by checking the appropriate blocks:

If this proposal results in a contract or grant, the offeror grants ARO the authority to release the following portion of its proposal in response to requests under the Freedom of Information Act, only after such award, without prior contact with the offeror:

Cover Page	( ) Yes	( ) No	Statement of Work	( ) Yes	( ) No
Project Abstract	( ) Yes	( ) No	Biographical Sketch	( ) Yes	( ) No
Technical Proposal	( ) Yes	( ) No	Cost Proposal/Budget	( ) Yes	( ) No
Current & Pending Support	( ) Yes	( ) No	Bibliography	( ) Yes	( ) No

______________ ______________________________

Date Signature of person authorized to sign for organization

______________ ______________________________

Date Signature of Principal Investigator

ARO Form 52
(Revised June 95)

USE THIS FORM FOR INDUSTRIAL CONTRACTORS

PROTECTION OF PROPRIETARY INFORMATION DURING EVALUATION AND AFTER AWARD

It is the policy of the US Army Research Office to treat all research proposals as privileged information prior to award and to disclose the contents only for purposes of evaluation. Technical evaluation of these proposals normally are made by highly qualified scientists from the Government and leading scientists and other preeminent experts outside the Government to ascertain the merits of the proposal. While you may, if you wish, restrict the evaluation of your proposal to only scientists within the Government, to do so may prevent it from receiving an evaluation by those most qualified in the field of your proposal. Therefore, we ask permission to send your proposal outside of the Government if that is necessary to obtain an unrestricted evaluation by such qualified individuals.

All reviewers are made aware that proposals sent to them shall not be duplicated, used, or disclosed in whole or in part for any purpose other than to evaluate the proposal, without the written permission of the offeror.

You should be aware that despite all precautions, we can protect the confidentiality of proprietary information contained in proposals only to the extent that it is exempt from disclosure under the Freedom of Information Act (FOIA; 5 U.S.C. 552). Generally, Exemption 4 of the FOIA (5 U.S.C. 552(b)(4)) will protect from release information submitted to the Government that constitutes either (1) a trade secret or (2) commercial or financial information which is privileged or confidential. Any such proprietary information contained in your proposal should be marked in accordance with FAR 15.509.

Please complete the following statement indicating your preference for treatment of your proposal during the evaluation phase and, should a grant or contract be awarded, after award.

STATEMENT OF DISCLOSURE PREFERENCE

____________________ in submitting proposal ____________________

(Organization) (Title)

____________________ with ____________________

(Name)

as Principal Investigator require the following procedure be used during its evaluation:

( ) Permission is hereby granted to the US Army Research Office to evaluate this proposal in accordance with its normal procedures which may include evaluation by evaluators both within and outside the Government with the understanding that written agreement not to disclose the information contained therein shall not be obtained from any nongovernment evaluators. Permission to release outside the Government, for evaluation purposes only, those pages of the proposal marked in accordance with FAR 15.509 is hereby granted, except for the following pages or sections: ____________________

____

( ) Restrict the evaluation of the above proposal to Government personnel only.

To reduce administrative requirements, you may complete the following information by checking the appropriate blocks:

If this proposal results in a contract or grant, the offeror grants ARO the authority to release the following portion of its proposal in response to requests under the Freedom of Information Act, only after such award, without prior contact with the offeror:

Cover Page	( ) Yes	( ) No	Statement of Work	( ) Yes	( ) No
Project Abstract	( ) Yes	( ) No	Biographical Sketch	( ) Yes	( ) No
Technical Proposal	( ) Yes	( ) No	Cost Proposal/Budget	( ) Yes	( ) No
Current & Pending Support	( ) Yes	( ) No	Bibliography	( ) Yes	( ) No

____________ Date

____________________ Signature of person authorized to sign for organization

____________ Date

____________________ Signature of Principal Investigator

ARO Form 52A
(Revised June 95)

USE THIS FORM FOR EDUCATIONAL INSTITUTIONS AND NON-PROFIT ORGANIZATIONS

PROJECT ABSTRACT

The Project Abstract shall include a statement of objectives, methods to be employed, and the significance of the proposed activity to the advancement of knowledge or education. Avoid use of the first person to complete this summary. DO NOT EXCEED ONE PAGE. The abstract should be suitable for release under the Freedom of Information Act, 5 U.S.C. 552, as amended.

PROJECT DESCRIPTION

BIOGRAPHICAL SKETCH

Provide the following information for the senior personnel on the project. Begin with the Principal Investigator/Project Director.

DO NOT EXCEED THREE PAGES PER PERSON

NAME **POSITION TITLE**

EDUCATION

(Begin with Baccalaureate or other initial professional education and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY

THE FOLLOWING ADDITIONAL INFORMATION IS REQUIRED:

A. List up to 5 publications most closely related to the proposed project and up to 5 other significant publications, including those being printed. Patents, copyrights or software systems developed may be substituted for publications. Do not include additional lists of publications, invited lectures, etc.

B. List of persons, other than those cited in the publication list, who have collaborated on a project or a book, article, report or paper within the last 48 months. Negative reports should be indicated.

C. Names of graduate and post-graduate advisors and advisees.

The information in B. and C. is used to help identify potential conflicts or bias in the selection of reviewers.

BIBLIOGRAPHY

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate): $ **Period Covered:**
Location of Research:
Person-Months Committed to the Project. **Cal:** **Acad:** **Summ:**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate): $ **Period Covered:**
Location of Research:
Person-Months Committed to the Project. **Cal:** **Acad:** **Summ:**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate): $ **Period Covered:**
Location of Research:
Person-Months Committed to the Project. **Cal:** **Acad:** **Summ:**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate): $ **Period Covered:**
Location of Research:
Person-Months Committed to the Project. **Cal:** **Acad:** **Summ:**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Award Amount (or Annual Rate): $ **Period Covered:**
Location of Research:
Person-Months Committed to the Project. **Cal:** **Acad:** **Summ:**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

USE ADDITIONAL SHEETS AS NECESSARY

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Mark the facilities to be used at each performance site listed and, as appropriate, briefly indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. Use additional pages if necessary.

Laboratory:

Clinical:

Animal:

Computer:

Office:

Other: (______________________________)

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate, identify the location and pertinent capabilities of each.

ADDITIONAL INFORMATION: Provide any other information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

SUMMARY
PROPOSAL BUDGET
Year ____

FOR ARO USE ONLY		
PROPOSAL NO.	DURATION (MONTHS)	
	Proposed	Granted
AWARD NO.		

OFFEROR

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	Man Hrs/Mos	Rate	Person-mos.			Funds Requested By Offeror	Funds Granted By ARO (If Different)
			CAL	ACAD	SUMR		
1.						$	$
2.							
3.							
4.							
5.							
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)							
7. ( ) TOTAL SENIOR PERSONNEL (1-6)							
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)	▨	▨	▨	▨	▨	▨	▨
1. ( ) POST DOCTORAL ASSOCIATES							
2. ( ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)							
3. ( ) GRADUATE STUDENTS							
4. ( ) UNDERGRADUATE STUDENTS							
5. ( ) SECRETARIAL - CLERICAL							
6. ( ) OTHER							
TOTAL SALARIES AND WAGES (A + B)							
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							
D, PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM. ATTACH ADDITIONAL EXPLANATION PAGES, IF NECESSARY.)						▨	▨
TOTAL PERMANENT EQUIPMENT							
E. TRAVEL (LIST ON BUDGET EXPLANATION PAGE)						▨	▨
1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)							
2. FOREIGN							
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $__________ 2. TRAVEL __________ 3. SUBSISTENCE __________ 4. OTHER __________						▨	▨
( ) TOTAL PARTICIPANT COSTS							
G. OTHER DIRECT COSTS (ITEMIZE ON BUDGET EXPLANATION PAGE)						▨	▨
1. MATERIALS AND SUPPLIES							
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							
3. CONSULTANT SERVICES							
4. COMPUTER (ADPE) SERVICES							
5. SUBAWARDS							
6. OTHER							
TOTAL OTHER DIRECT COSTS							
H. TOTAL DIRECT COSTS (A THROUGH G)							
I. INDIRECT COSTS						▨	▨
TOTAL INDIRECT COSTS							
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							
K. FEE (_____%) (BASE $)							
L. COST SHARING							
M. AMOUNT OF THIS REQUEST							

	Rate	Base	Total
Overhead			
G & A			
Fringe			
FCCM			

PI/PD TYPED NAME & SIGNATURE	DATE	FOR ARO USE ONLY
OFFERORS REP. TYPED NAME & SIGNATURE	DATE	

CONTRACT PRICING PROPOSAL COVER SHEET

1. SOLICITATION/CONTRACT/MODIFICATION NO.

FORM APPROVED OMB NO.
9000-0013

Public reporting burden for this collection of information is estimated to average 4 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the FAR Secretariat (VRS), Office of Federal Acquisition and Regulatory Policy, GSA, Washington, D. C. 20405; and to the Office of Management and Budget, Paperwork Reduction Project (9000-0013), Washington, D.C. 20503.

NOTE: This form is used in contract actions if submission of cost or pricing data is required (See FAR 15.804-6(b))

2. NAME AND ADDRESS OF OFFEROR (Include ZIP Code)

3A. NAME AND TITLE OF OFFEROR'S POINT OF CONTACT

3B. TELEPHONE NO.

4. TYPE OF CONTRACT ACTION (Check)

☐ A. NEW CONTRACT	☐ D. LETTER CONTRACT
☐ B. CHANGE ORDER	☐ E. UNPRICED ORDER
☐ C. PRICE REVISION/ REDETERMINATION	☐ F. OTHER (Specify)

5. TYPE OF CONTRACT (Check)

☐ FFP ☐ CPFF ☐ CPIF ☐ CPAF
☐ FPI ☐ OTHER (Specify)

6. PROPOSED COST (A+B=C)

A. COST	B. PROFIT/FEE	C. TOTAL
$	$	$

7. PLACE(S) AND PERIOD(S) OF PERFORMANCE

8. List and reference the identification, quality and total price proposed for each contract line item. A line item cost breakdown supporting this recap is required unless otherwise specified by the Contracting Officer. (Continue on reverse, and then on plain paper, if necessary, use same headings.)

A. LINE ITEM NO.	B. IDENTIFIC~~ATION~~	C. QUANTITY	D. TOTAL PRICE	E. REF

9. PROVIDE NAME, ADDRESS, AND TELEPHONE NUMBER FOR THE FOLLOWING (If available)

A. CONTRACT ADMINISTRATION OFFICE

B. AUDIT OFFICE

10. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS WORK? (If "yes," identify)

☐ YES ☐ NO

11A. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT? (If "Yes," complete Item 11B)

☐ YES ☐ NO

11B. TYPE OF FINANCING (X one)

☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS
☐ GUARANTEED LOANS

12. HAVE YOU BEEN AWARDED FOR ANY CONTRACTS OR SUBCONTRACTS FOR THE SAME OR SIMILAR ITEMS WITHIN THE PAST 3 YEARS? (If "Yes," identify item(s), customer(s) and contract number(s))

☐ YES ☐ NO

13. IS THIS PROPOSAL CONSISTENT WITH YOUR ESTABLISHED ESTIMATING AND ACCOUNTING PRACTICES AND PROCEDURES AND FAR PART 31, COST PRINCIPLES? (If "No," explain)

☐ YES ☐ NO

14. COST ACCOUNTING STANDARD BOARD (CASB) DATA (Public Law 91-379 as amended and FAR PART 30)

A. WILL THIS CONTRACT ACTION BE SUBJECT TO CASB REGULATIONS? (If "No," explain in proposal)

☐ YES ☐ NO

B. HAVE YOU SUBMITTED A CASB DISCLOSURE STATEMENT (CASB DS-1 or 2)? (If "Yes," specify in proposal the office to which submitted and if determined to be adequate)

☐ YES ☐ NO

C. HAVE YOU BEEN NOTIFIED THAT YOU ARE OR MAY BE IN NON-COMPLANCE WITH YOUR DISCLOSURE STATEMENT OR COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)

☐ YES ☐ NO

D. IS ANY ASPECT OF THIS PROPOSAL INCONSISTENT WITH YOUR DISCLOSED PRACTICES OR APPLICABLE COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)

☐ YES ☐ NO

This proposal is submitted in response to the RFP, contract, modification, etc. in Item 1 and reflects our best estimates and/or actual costs as of this date and conforms with the instructions in FAR 15.804-6(b) (2), Table 15-2. By submitting this proposal, the offeror, if selected for negotiation, grants the contracting officer or an authorized representative the right to examine, at any time before award, those books, records, documents and other types of factual information, regardless of form or whether such supporting information is specifically referenced or included in the proposal as the basis for pricing, that will permit an adequate evaluation of the proposed price.

15. NAME AND TITLE (Type)

16. NAME OF FIRM

17. SIGNATURE

18. DATE OF SUBMISSION

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7/87 edition is usable.

EXPIRATION DATE 7-31-93

1411-103

STANDARD FORM 1411 (REV. 2-91)
Prescribed by GSA - FAR (48 CFR) 53.215-2(a)

CONTRACT FACILITIES CAPITAL COST OF MONEY

Form Approved
OMB No. 0704-0267
Expires Feb 28, 1995

Public reporting burden for this collection of information is estimated to average 10 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0267), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO EITHER OF THESE ADDRESSES.
RETURN COMPLETED FORM TO YOUR CONTRACTING OFFICIAL.

1. CONTRACTOR NAME

2. CONTRACTOR ADDRESS

3. BUSINESS UNIT

4. RFP/CONTRACT PIIN NUMBER

5. PERFORMANCE PERIOD

6. DISTRIBUTION OF FACILITIES CAPITAL COST OF MONEY

POOL a.	ALLOCATION BASE b.	FACILITIES CAPITAL COST OF MONEY c.	
		FACTOR (1)	AMOUNT (2)
d. TOTAL			
e. TREASURY RATE			%
f. FACILITIES CAPITAL EMPLOYED (TOTAL DIVIDED BY TREASURY RATE)			

7. DISTRIBUTION OF FACILITIES CAPITAL EMPLOYED

	PERCENTAGE a.	AMOUNT b.
(1) LAND	%	
(2) BUILDINGS	%	
(3) EQUIPMENT	%	
(4) FACILITIES CAPITAL EMPLOYED	100%	

DD FORM 1861, MAR 93

PREVIOUS EDITION IS OBSOLETE

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